RDT&E CENTER MANAGEMENT BRIEFS

VOLUME I

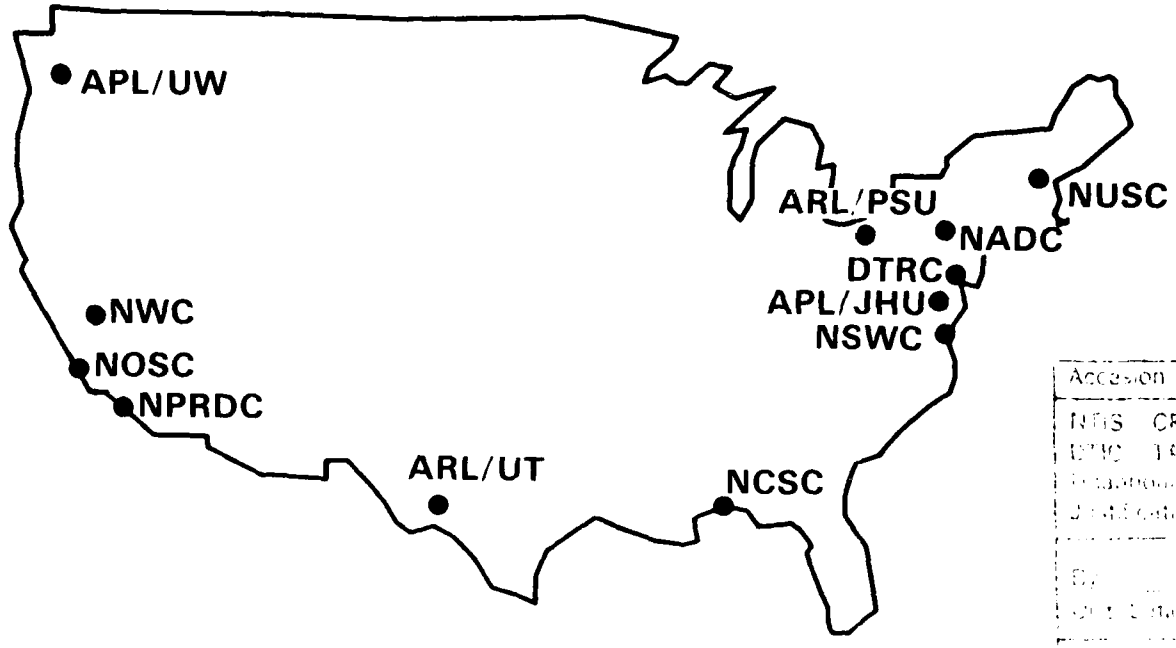
SPACE AND NAVAL WARFARE SYSTEMS COMMAND
R&D CENTERS & UNIVERSITY LABORATORIES

DTRC • NADC • NCSC • NOSC
NPRDC • NSWC • NUSC • NWC
APL/JHU • APL/UW • ARL/PSU • ARL/UT

SPACE AND NAVAL WARFARE SYSTEMS COMMAND
WASHINGTON, DC

30 SEPTEMBER 1987

LOCATION OF CENTERS



DTRC	– DAVID TAYLOR RESEARCH CENTER
NADC	– NAVAL AIR DEVELOPMENT CENTER
NCSC	– NAVAL COASTAL SYSTEMS CENTER
NOSC	– NAVAL OCEAN SYSTEMS CENTER
NPRDC	– NAVY PERSONNEL RESEARCH AND DEVELOPMENT CENTER
NSWC	– NAVAL SURFACE WARFARE CENTER
NUSC	– NAVAL UNDERWATER SYSTEMS CENTER
NWC	– NAVAL WEAPONS CENTER
APL/JHU	– APPLIED PHYSICS LABORATORY/JOHNS HOPKINS UNIVERSITY
APL/UW	– APPLIED PHYSICS LABORATORY/UNIVERSITY OF WASHINGTON
ARL/PSU	– APPLIED RESEARCH LABORATORY/PENNSYLVANIA STATE UNIVERSITY
ARL/UT	– APPLIED RESEARCH LABORATORY/UNIVERSITY OF TEXAS

FOREWORD

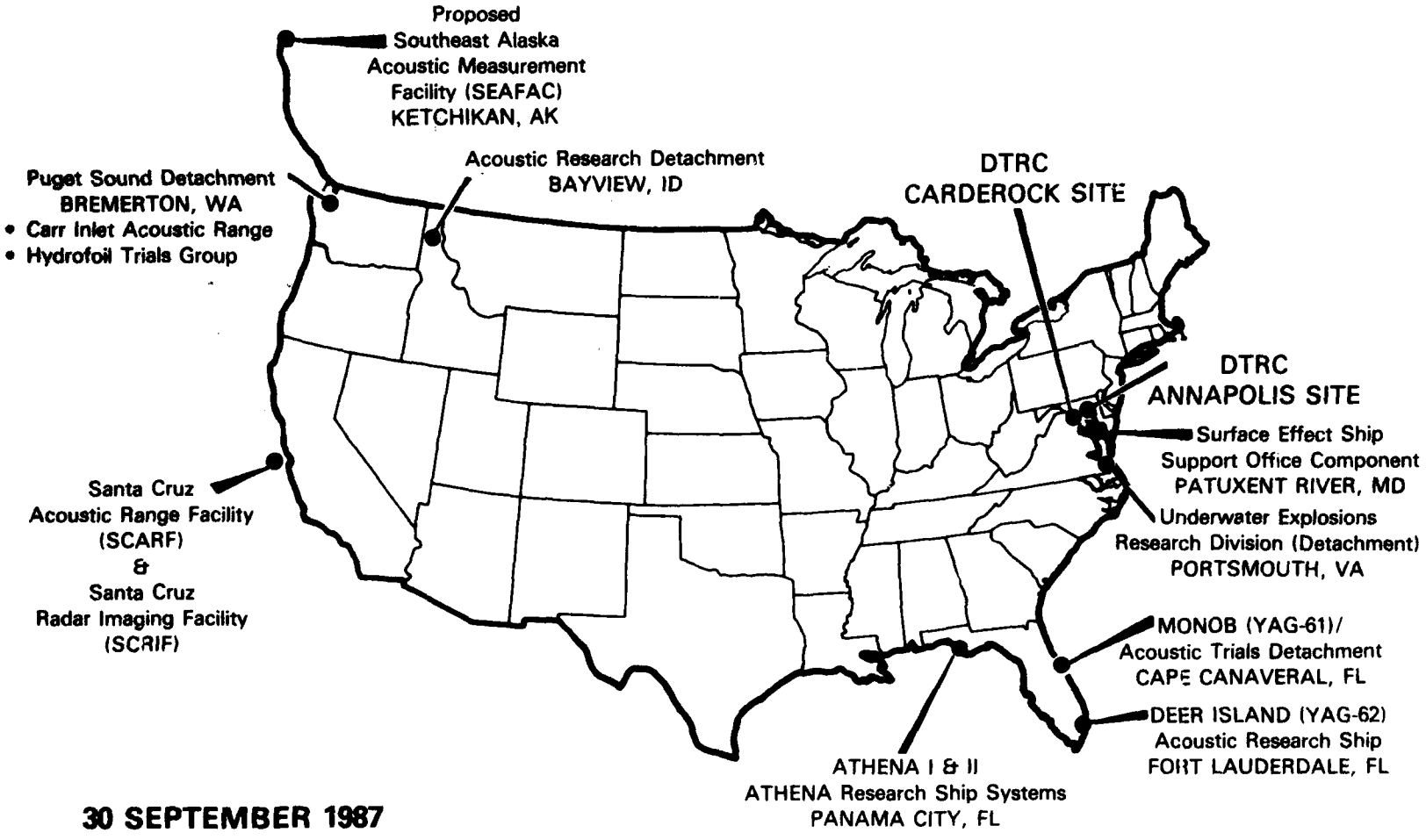
The attached RDT&E center management briefs contain information relative to the missions, facilities, programs, major accomplishments, organization, personnel, funds, and functions/responsibilities of each Space and Naval Warfare Systems Command R&D Center and University Laboratory. The briefs are intended to provide an accessible source of information pertinent to overall operations of the COMSPAWARSYSCOM R&D Centers and University Laboratories. Users are encouraged to provide SPAWAR 005 with any suggestions regarding the briefs (format, content, etc.).

David Taylor Research Center
Bethesda, MD 20084-5000 DTRC—87/CT12 30 September 1987

DTRC BRIEF

DTRC

DAVID TAYLOR RESEARCH CENTER, DETACHMENTS AND FACILITIES



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DTRC

MISSION

TO BE THE PRINCIPAL NAVY RDT&E CENTER
FOR NAVAL VEHICLES AND LOGISTICS AND FOR PROVIDING
RDT&E SUPPORT TO THE U.S. MARITIME ADMINISTRATION
AND THE MARITIME INDUSTRY

REF. NAVMATINST 5450.27C DATED 1 AUGUST 1983

30 SEPTEMBER 1987

INTRODUCTION

The David Taylor Research Center (DTRC) was established on 31 March 1967 with the merger of the David Taylor Model Basin at Carderock, Maryland and the Marine Engineering Laboratory at Annapolis, Maryland. These two laboratories have contributed to the U.S. Navy since their formation in 1896 and 1903, respectively.

The Center is dedicated to research and development conducted by nine technical departments:

- Ship Systems Integration
- Ship Hydromechanics
- Ship Structures and Protection
- Ship Acoustics
- Ship Electromagnetic Signatures
- Propulsion and Auxiliary Systems
- Ship Materials Engineering
- Aviation
- Computation, Mathematics and Logistics

Major RDT&E programs are conducted in naval vehicle systems and subsystems, logistics, and other mission related work.

Primary research and development facilities include shallow and deep water towing basins, a maneuvering and seakeeping basin, water and wind tunnels, an anechoic flow facility, underwater explosions laboratory barge, and large pressure tanks. The Center has laboratories for submarine internal fluid dynamics, structural evaluation, metallurgical characterization and evaluation, welding and fabrication, environmental protection, fire protection, corrosion, nonmetallic materials development, machinery development, fuels, turbo-electric propulsion, and electric power generation.

The Center conducts research and development at four detachments and nine facilities; four of these facilities are Government-owned, Contractor-operated (GOCO):

Detachments:

- Puget Sound Detachment, Bremerton, WA
- Acoustic Research Detachment, Bayview, ID
- Underwater Explosions Research Division (Detachment), Portsmouth, VA
- Acoustic Trials Detachment, Cape Canaveral, FL

Facilities:

- Athena I & II (GOCO), Panama City, FL
- Deer Island (YAG-62) (GOCO), Ft. Lauderdale, FL
- Surface Effects Ship Support Office Component, Patuxent River, MD
- Carr Inlet Acoustic Range, Puget Sound, WA
- Santa Cruz Acoustic Range Facility (GOCO), Santa Barbara, CA
- Santa Cruz Radar Imaging Facility, Santa Barbara, CA
- MONOB (YAG-61) (GOCO), Cape Canaveral, FL
- Jupiter II, Annapolis, MD
- Seneca (AF) Dockside, Annapolis, MD

The Fleet Support Office provides direct fleet interface and manages the Center's Navy Science Assistance Program (NSAP) efforts.

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INTRODUCTION (CONTINUED)

On 30 September 1987, the Center had 2792 permanent and temporary employees and 65 military personnel. Total funding for FY 1987 was $316.6 million. Over 50% of this funding was received from the Naval Sea Systems Command, the Center's major sponsor. Other major sponsors include the Naval Air Systems Command, Space and Naval Warfare Systems Command, Naval Supply Systems Command, Marine Corps, Office of Naval Research and Office of Naval Technology. Real Property and Equipment assigned to DTRC have an acquisition cost value of $180 million.

HISTORY

The David Taylor Research Center (DTRC) is the largest facility of its type in the Western World. The Center is named for the late Rear Admiral David W. Taylor, Naval Constructor, who was the driving force behind the creation of the Experimental Model Basin at the Washington Navy Yard.

The Experimental Model Basin was established by Congress on 10 June 1896, "for investigating and determining the most suitable and desirable shapes: (for) U.S. naval vessels." It also provided that: ". . . experiments may be made at this establishment for private shipbuilders, who shall defray the cost . . . for such experiments."

The Experimental Model Basin began operations in 1898 with Navy ship model studies in the towing tank. In 1914, a wind tunnel to study Navy aircraft models was built, for many years the largest wind tunnel in the world. Work for Model Basin experimentation outgrew the space at the Navy Yard, however, and on 6 May 1936, Congress approved "an Act to authorize the construction of a Model Basin establishment...for U.S. vessels including aircraft and the investigation of other problems of ship design . . ." The Act also contained a provision to make experiments for private shipbuilders. On 5 October 1937, the Secretary of the Navy named the new establishment the David W. Taylor Model Basin. The Basin became operational in 1940.

At the turn of the 20th century, Rear Admiral George W. Melville, USN, then Chief of the Bureau of Steam Engineering, recognized the need to develop fleet standards for machinery operation and maintenance. In 1900, he asked Congress to establish a steam engineering experiment station and testing laboratory. In 1903, Congress approved the Engineering Experiment Station at Annapolis.

The post World War II years brought dramatic changes to EES as original testing concepts evolved into research and development. In 1963 the EES was renamed the "Marine Engineering Laboratory" reflecting the trend to R&D in marine systems. The departments at the Annapolis site are active in machinery silencing, propulsion machinery, auxiliary machinery systems, marine anti fouling coatings, corrosion, metal alloys and piping systems.

The Naval Ship Research and Development Center was established on 31 March 1967 with the merger of the Model Basin and the Marine Engineering Laboratory. The name of David W. Taylor was restored to the Center's title on 1 July 1975. On 18 September 1987 the Center was renamed David Taylor Research Center (DTRC).

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DTRC

MAJOR FACILITIES

SHIP PERFORMANCE DEPARTMENT

- Shallow Water Towing Basin
- Deep Water Towing Basin
- High Speed Towing Basin
- Towing Carriages
- Circulating Water Channel
- Maneuvering and Seakeeping Basin
- ATHENA Research Ship Systems (ATHENA I & II)
- Rotating Arm Basin
- 36", 24" and 12" Water Tunnels
- Dynamic Control System Simulator

SHIP ACOUSTICS DEPARTMENT

- Anechoic Flow Facility
- Vibration Analysis Facility
- Acoustic Data Analysis Center
- Radiated Noise Measurement Facilities
  - MONOB (YAG-61), Cape Canaveral, FL
  - DEER ISLAND (YAG-62), Ft. Lauderdale, FL
  - Carr Inlet Acoustic Range Facility, Puget Sound, WA
  - Santa Cruz Acoustic Range Facility, Santa Barbara, CA
- Acoustic Research Detachment, Bayview, ID
  - KAMLOOPS
  - DOLLY VARDEN
  - Large Scale Vehicle
  - STEELHEAD

AVIATION DEPARTMENT

- Two 8- x 10-Foot Subsonic Wind Tunnels
- 7- x 10-Foot Transonic Wind Tunnel

SHIP STRUCTURES AND PROTECTION DEPARTMENT

- Structural Evaluation Laboratory
- Pressure Tanks and Cyclic Pressure System
- Underwater Explosions Barge (UEB-1), Portsmouth, VA

PROPULSION AND AUXILIARY SYSTEMS DEPARTMENT

- Machinery Systems Simulation Facility
- Machinery Acoustics Analysis Center
- Submarine Fluid Dynamics Facility
- Deep Ocean Technology High-Pressure Facility
- Magnetic Fields Laboratory
- Propulsion Test Craft -- Jupiter II and Seneca
- Special Equipment Laboratories for studying:
  - Submarine Machinery Noise
  - Submarine Propulsion Systems
  - Advanced Electric Drive
  - Shipboard Electrical Power
  - Shipboard Auxiliary Machinery
  - Engines

SHIP MATERIALS ENGINEERING DEPARTMENT

- Special Equipment Laboratories for studying:
  - Fire Protection and Survivability
  - Metallurgical Properties
  - Chemical Properties
  - Materials Failure
  - Fitness for Service
  - Welding Fabrication and NDE
  - Pollution Abatement
  - Paints and Coatings
  - Plastics, Composites, and Elastomers
  - Signature Reduction Materials
  - High Temperature Materials Performance
  - Lubrication and Wear

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MAJOR FACILITIES (CONTINUED)

SHIP SYSTEMS INTEGRATION DEPARTMENT

- Surface effect ship test craft (SES 200)
- Advanced Design Center

COMPUTATION, MATHEMATICS AND LOGISTICS DEPARTMENT

- Scientific Computer Facility (Supports Entire Center)
  - CDC CYBER 176
  - CDC CYBER 750
  - CDC 825/MSS (Mass Storage System)
  - 2 VAX 11/780
- Technical Office Automation and Communication System (TOFACS)
  - 3 VAX 11/780
  - 1 ISI V-24S
  - 1 ISI V-16S
  - 700 Workstations

SHIP ELECTROMAGNETIC SIGNATURES DEPARTMENT

- Radar Image Modeling System (RIMS)
- Image Processing Facility
- Control Systems Laboratory
- Central Instrumentation
- Systems Integration Computer Facility

The laboratories located at Carderock and Annapolis, MD are unique national assets. The hydrodynamic facilities are the largest, and the best, of their type in the western world. The Annapolis site has additional facilities, as well as shallow-water docking and access to the fleet via the Chesapeake Bay.

DAVID TAYLOR MODEL BASIN

The David Taylor Model Basin is housed in a building 3,150 feet long. It is covered by an arched roof with a span of 110 feet. The building contains Deep Water Basins Numbers 1 and 2, a shallow water and turning basin; and a High Speed Basin which runs parallel to the other basins. The deep water basins are 51 feet wide and 22 feet deep, with lengths of 889 feet and 1886 feet, separated by a pneumatic wavemaker which creates waves in Deep Water Basin Number 2. The shallow water basin joins the Deep Water Basin Number 1, then doubles back in a J-shaped curve to form a turning basin, where models can undergo maneuvering and turning experiments; it is 10 feet deep. The High Speed Basin is 21 feet wide, 2,968 feet long, 10 feet deep for one-third of its length, and 16 feet deep for its remaining length. It has a pneumatic wavemaker which provides waves of uniform length and height. The basins have electrohydraulic drive towing carriages to tow models through the water. Maximum carriage speeds for each basin are: Deep Water Basin Number 1 and Shallow Water Basin – 18 knots (Carriage 1); Deep Water Basin Number 2 – 20 knots (Carriage 2); High Speed Basin – 55 knots (Carriage 5). Carriage 3 operates over the High Speed Basin at speeds up to 40 knots, and has unique gear for accommodating surface effects ship experiments.

CIRCULATING-WATER CHANNEL

The Circulating-Water Channel has an open test section 22 feet wide and 60 feet long in which a stream of water up to 9 feet deep flows at a maximum speed of 10 knots The channel has a

MAJOR FACILITIES (CONTINUED)

capacity of 664,000 gallons. Water is pumped through a circuit, closed except for the open-top test section, by two propeller-type pumps, 12½ feet in diameter, that are driven by direct-connected 1250-horsepower electric motors. The motors rotate at constant speed, and the rate of flow of the water is regulated by adjusting the pitch of the propeller blades while the pumps are running. Large windows are placed in the walls and bottom of the test section for visual observations and for photography. The object under test is held stationary in the moving stream, and the forces exerted by the water are measured by dynamometers.

MANEUVERING AND SEAKEEPING BASIN

The Harold E. Saunders Maneuvering and Seakeeping Facilities (MASK) are housed in a building that covers five acres of land. The rectangular seakeeping basin is 240 feet wide, 360 feet long, and 20 feet deep except for a 35 foot deep section. The basin is used for both restrained and free-running models. Model motions, accelerations, control surface deflections and strains are typically measured during each experiment. Eight pneumatic wavemakers on the west end and 13 on the north side generate the waves. A wide variety of simulated sea states can be programmed on magnetic tape. Concrete wave absorbers with fixed bars act as a beach and are effective in preventing wave reflection. The towing carriage runs below a steel girder which is mounted on tracks at the ends of the basin so that the heading of the carriage can be changed. This allows models to be towed in seas of any angle. The carriage can tow at speeds up to 15 knots. The Rotating Arm Facility, also located in this building, is a round basin constructed of reinforced concrete. Models are towed in a circle to determine turning capability. The facility is capable of speeds up to 50 knots. It can accommodate surface models up to 30 feet and submarines up to 20 feet in length.

WATER TUNNELS

The Center has three water tunnels which have test sections 12, 24, and 36 inches in diameter. Water speeds vary from 14 to 50 knots. The water tunnels are closed duct circuits set up in a vertical plane. Water is circulated by a motor-driven impeller located in the lower horizontal portion of the tunnel. The test section and shaft for mounting experimental propellers and propulsion systems are in the upper portion. Vacuum pumps lower the air pressure above the water in the tunnel's chamber controlling the pressure on the model. For propellers, this corresponds to the combined effect of atmosphere and water pressure on the propeller of a full size ship, and allows simulation of full-scale cavitation patterns on the model.

ANECHOIC FLOW FACILITY

The Anechoic Flow Facility combines a very quiet, low turbulence air-flow facility with an anechoic chamber used to make acoustic measurements. The combination enables researchers to study the generation mechanism of flow noise associated with submarines, ships, torpedoes, and large appendages. The Facility has two areas in which measurements can be made: a nine-foot long closed jet test section of eight foot square cross-section, and a 21-foot long open-jet test section surrounded by an anechoic chamber of 21-foot square cross-section. The maximum air speed in the facility is 200 feet per second. Six screens upstream of the test sections reduce turbulence to the desired 0.1 percent. Noise at full speed is less than that of conversational speech. Models up to 20 feet long may be mounted in the facility.

TRANSONIC WIND TUNNEL

The 7- by 10-foot Transonic Wind Tunnel is a closed circuit, single return tunnel, with a test section that is 7 feet high, 10 feet wide,

MAJOR FACILITIES (CONTINUED)

19 feet long, with a contraction ratio of 14.481. It is constructed of reinforced concrete in low velocity portions of the circuit, and of machined steel in the remainder. The facility is capable of operating continuously over a Mach number range from 0.2 to 1.1. The facility is the Navy's only transonic wind tunnel, and is the largest transonic facility capable of conducting aircraft/weapons separation experiments. The low speed leg of the tunnel is currently being modified to provide an additional V/STOL aircraft capability.

PRESSURE TANKS AND CYCLIC PRESSURE SYSTEM

To verify the structural adequacy of new submarine designs, accurately scaled models of various sizes are subject to hydrostatic and cyclic loading patterns in pressure tanks. The Center's major pressure tanks range in size from 17½ inches in diameter to 13 feet in diameter; and range in operating pressure capability from 25,000 psi to 3,000 psi. Each of the tanks has the highest operating pressure for its diameter of any quick opening tank in the United States. Using a pressurized system developed and patented by Center engineers, cyclic experiments may be conducted by varying the pressure within the model and keeping the tank pressure constant. The 10-foot diameter tank, which has a static capacity of 12,000 psi and cyclic capacity of 4,000 psi at one complete cycle per minute, can be used for testing either full-size deep-diving submersibles or bottom-sitting devices. Internal lighting and closed-circuit television systems allow viewing of test at simulated deep ocean environmental conditions. In some cases men have been inside the submersible during pressure test.

SUBMARINE FLUID DYNAMICS FACILITY

This facility consists of two primary complexes; the Submarine Emergency Ballast Blow Tank and the Submarine Steering and Diving Control Systems. The Submarine Emergency Ballast Blow Tank Complex was originally designed for the study of the ballast-blow process in submarines. It is now used as a prime source of high pressure or high rate flows of air or water for a variety of purposes.

The Submarine Steering and Diving Control System Complex was designed to evaluate the TRIDENT submarine control system performance under simulated dynamic load conditions. However, it is adaptable to a variety of needs with minor modifications. It provides for the evaluation of performance, flow, functional, and acoustic characteristics of electro-hydraulic servo valves up to 3,000 psi and 160 gallons per minute in continuous operation.

MONOB (YAG-61)

The Acoustic Research Ship MONOB (YAG-61) is home ported in Cape Canaveral, Florida. Manned by a civilian contract crew, the ship has a staff of 25 scientists, engineers, and technicians, who conduct tests in support of the Naval Sea Systems Command Submarine Noise Reduction Program. MONOB is equipped with advanced data acquisition processing and analysis equipment. She represents the Navy's primary East Coast Radiated Noise Measurement Facility, with approximately 25 trials a year, with at-sea time near 200 days.

DEER ISLAND (YAG-62)

The Acoustic Research Vessel DEER ISLAND (YAG-62) operates from Ft. Lauderdale, Florida. DEER ISLAND was acquired from SUPSHIPS Pascagoula and is the primary facility supporting the Naval Sea Systems Command Noise Reduction Program. The ship was acquired due to rapid expansion of the Surface Ship

MAJOR FACILITIES (CONTINUED)

Silencing Program. She is equipped with advanced noise acquisition processing and analysis equipment and conducts about 50 trials per year.

CARR INLET ACOUSTIC RANGE (CIAR)

CIAR, located at Fox Island, Puget Sound, Washington, is used to support both the Surface Ship and Submarine Noise Reduction Programs. CIAR has the unique capability to suspend a submarine in free water while supplying up to 1600 amps shore power for special tests. This capability maximizes the efficient use of time and minimizes crew fatigue during acoustical trials, since the ship is always in the measurement area and is not required to maneuver between test runs. In addition, since the ship's propulsion and power generating plants can be shut down while operating on shore power, the effects of individual auxiliary systems or components on the ship's noise signatures can be evaluated. CIAR has a bottom-mounted tracking system for submarine maneuvering and positioning, along with state-of-the-art data acquisition processing and analysis systems.

SANTA CRUZ ACOUSTIC RANGE FACILITY (SCARF)

SCARF is located on Santa Cruz Island, California, and is used to support the Surface Ship and Submarine Noise Reduction Programs. It, too, is equipped with a bottom-mounted tracking and positioning system and the latest data acquisition, processing and analysis systems. It supports submarine high speed radiated noise reduction efforts on the West Coast.

SANTA CRUZ RADAR IMAGING FACILITY (SCRIF)

SCRIF was acquired by DTRC in FY 87 as part of the Center's increasing emphasis on electromagnetic signatures technology and application. The facility is located on Santa Cruz Island (not contiguous to SCARF) and can perform full-scale radar imaging measurements at four different wavelengths. A SCRIF upgrade is in progress.

SURFACE EFFECT SHIP SUPPORT OFFICE COMPONENT

The Surface Effect Ship Support Office Component (SESSO Component) was established in 1984 to operate and maintain the prototype Surface Effect ship, SES 200, and other test craft. The SES 200 is being used in operational demonstrations with the U.S. and NATO Navies to provide familiarization with surface effect ship characteristics and capabilities and to allow a "quick look" evaluation of SES potential in various mission roles and operational demonstrations in support of the Coast Guard and NATO.

In addition to its primary mission relative to the operation and maintenance of the SES 200, the SESSO Component provides a capability to conduct research, development, tests and trials.

ATHENA RESEARCH SHIP SYSTEMS (ATHENA I & II)

ATHENA Research Ship Systems primarily supports Navy RDT&E programs, but are also available to other government agencies and private industry. Powered by twin diesels or a gas turbine through variable pitch propellers, and capable of speeds up to 35 knots, the ATHENAs are converted patrol gunboats of the ASHEVILLE class. Designed for offshore patrol and control of coastal traffic, they are fully capable of sustained at-sea operations. Since 1976, the ATHENA Research Ship Systems have seen extensive service in development of high speed towed sensors, airborne mine countermeasures, communication systems, and full scale validations of model theory for propeller

MAJOR FACILITIES (CONTINUED)

wake surveys and propeller stress studies. ATHENA operations are managed by the Naval Hydromechanics Division of the David Taylor Research Center.

COMPUTER FACILITIES

The Center's computer and hardware facilities serve the information processing needs of the Center as well as those of other Navy and government activities. Its components include:

- Large scale computer systems and related communications and peripheral equipment
- Local batch, remote batch, conversational and interactive graphics services
- Applications, utility and simulation software
- Data base management systems
- Personal computers and engineering workstations
- Local area networks
- Off-line plotting, printing, and microfiche equipment

The Center's computer and software systems continue to exploit advances in computer technology in order to provide the most modern capabilities to the Center's scientific staff.

The Systems Integration Computer Facility processes classified material. It is a dedicated system for general, interactive data processing, consisting of a VAX 11/780 minicomputer and peripherals, one Tektronics graphics terminal, one CALCOMP beltbed digital plotter, and a MAP 6420 array processor. Software includes CALCOMP DISSPLA and Tek Plot 10 Interactive Graphics Library.

FUTURE FACILITY PLANS:

- V/STOL Conversion of Transonic Wind Tunnel -- will provide new capability for low-speed aerodynamics testing, including support of V/STOL and rotorcraft development. Conversion is underway toward an FY 88 completion.

- Radar Image Modeling System (RIMS) will provide radar cross-section measurements of ship models in simulated ocean environment (the Maneuvering & Seakeeping Basin). Completion scheduled for FY 88.

- Southeast Alaska Acoustic Measurement Facility (SEAFAC) -- will provide water and shore facilities necessary for measurements of the radiated noise of quieter submarines. (FY 89 -- MILCON P-259.)

- Welding & NDE Laboratory -- will provide a facility for advanced welding methods and non-destructive evaluation with transition of this technology to fleet applications and direct support of fleet readiness tasks in these areas. (FY 89 -- PIF MILCON P-161).

- Shipboard Integrated Machinery Systems Laboratory -- will house developmental ship machinery systems for evaluation. This completely integrated test facility will allow effective integration and trade-offs of energy, silencing, and size while improving reliability, maintainability, availability, and survivability. (FY 90 MILCON P-143).

- Large Cavitation Channel -- This recirculating water test facility will have a 10 by 10 foot test section which can accept fully appended (with propulsors) models up to 40 feet in length.

MAJOR FACILITIES (CONTINUED)

Tests can be conducted at speed of 30 knots with variable pressure from ½ to 60 psia to improve the hydrodynamic, cavitation, noise and vibration characteristics of future surface ships and submarines. (IOC-1990.)

- Engineering Services Facility - will provide a facility to consolidate Center support functions including Public Works and Supply. (FY 91 - MILCON P-047.)

- Submarine Silencing Laboratory - will provide a unique anechoic water tank testing facility for quieting future submarines, development of quieter designs, scientific research on hydro acoustics, and increased fleet effectiveness and security. (FY 91 - MILCON P 046.)

- Concealment Materials Laboratory - will provide the Navy with new R&D capabilities in advanced materials science and technology to reduce detectability of surface ships, submarines, and advanced vehicles. (FY 92 - MILCON P-124.)

- Signature Reduction Laboratory - will provide a facility for developing technology and methodology of reducing ship electromagnetic signatures (above 1 MHz) of new designs and retrofits. (FY 95 - MILCON P-209.)

- Warship Integration Center - will enhance the transfer and integration of new technology into ship design, construction, and upkeep; upgrade the quality of ship designs; and reduce the time and cost of the ship design process (FY 94 - MILCON P-091.)

- USNS Hayes (T-AG) - A ship conversion project which will result in a MONOB replacement for the 1990's and beyond. The HAYES is a twin hulled vessel being modified to enable the conduct of acoustical trials both underway, using a towed array, and moored, when conducting more conventional ship trials. In addition, the HAYES will permit longer time on station and enable operation in a much greater variety of sea conditions.

- High Pressure Acoustic Tank (HAT) - will provide a controlled temperature-pressure environment for the acoustic evaluation of material samples in support of the Target Strength Reduction Program and other critical programs. A removable anechoic liner together with internal acoustic transducers, material sample mounts, positioning motors and sensors, and measurement support instrumentation will accommodate material samples of a size sufficient to demonstrate full-scale performance. The HAT facility will become operational in mid-1988.

PROPERTY DATA:

Land Owned:	325 Acres	Acquisition Costs:	
Land Leased:	0	Real Property	78.3 M
Buildings:		Equipment	101.7 M
Lab	1717 K sq. ft.		
Admin.	96 K sq. ft.		
Other	290 K sq. ft.		

CENTER DETACHMENTS

The Center also conducts research and development at four detachments, and utilizes nine off-station facilities including four which are government-owned, contractor-operated (GOCO). Detachments are the: Underwater Explosions Research Division Detachment, Portsmouth, Virginia; Acoustic Trials Detachment, Cape Canaveral, Florida; Puget Sound Detachment, Bremerton, Washington and the Acoustic Research Detachment, Bayview, Idaho. Off-station facilities include the: ATHENA Research Ship Systems (ATHENA I & II), Panama City, Florida (GOGO); the MONOB (YAG-61), Cape Canaveral, Florida (GOCO); MV DEER ISLAND (YAG-62), Ft. Lauderdale, Florida (GOCO); Carr Inlet Acoustic Range (CIAR), Fox Island, Puget Sound, Washington; Santa Cruz Acoustic Range Facility (SCARF), Santa Cruz Island, California (GOCO); Santa Cruz Radar Imaging Facility (SCRIF), Santa Cruz Island, California; JUPITER II, Annapolis, Maryland; SENECA (AF), Dockside, Annapolis, Maryland; and the Surface Effects Ship Support Office Component, Naval Air Station, Patuxent River, Maryland.

UNDERWATER EXPLOSIONS RESEARCH DIVISION DETACHMENT

PORTSMOUTH, VA

The Underwater Explosions Research Division (UERD), Portsmouth, VA and the Underwater Explosions Barge became operational in 1942 and have been part of the Center's Ship Structures and Protection Department since 1961. UERD annually conducts about 100 tests in the Norfolk Naval Shipyard's turning basin, and a few major tests at sea serving a variety of sponsors, including Naval Surface Warfare Center (NSWC), Naval Coastal Systems Center (NCSC), Naval Underwater Systems Center (NUSC), Naval Sea Systems Command (NAVSEA), and the Defense Nuclear Agency (DNA). The division was instrumental in establishing the design method and test procedure used to qualify the shock resistance of submarine pressure hull fittings, and the design, development and large scale verification of the torpedo side protection system for aircraft carriers. Due to UERD's historic presence in Portsmouth, explosion work is considered routine by the local population, an attitude which is extremely important in the age of environmental concern. UERD currently is developing ways to enhance the survivability of ships and submarines in extreme environments from underwater explosions, weapons impact and collisions. The Division is also working on the development of quantitative procedures to assess the effects of anti-surface and antisubmarine vehicle warheads, and the development, operation and maintenance of its test facilities. A heavy work load is expected to continue.

ACOUSTIC TRIALS DETACHMENT

CAPE CANAVERAL, FL

The Center's Acoustic Trials Branch was established in 1960 at Charleston, SC, and moved in 1969 to Port Everglades, FL to reduce transit time of the MONOB, Mobile Noise Barge (YAG-61), which operates primarily in the Bahamas. In 1978 the Barge and Detachment were moved to Cape Canaveral, where better shore support facilities were available. A seagoing laboratory, MONOB provides acoustic trials for submarines as part of the NAVSEA Submarine Noise Reduction Program. The ship is manned by a civilian contract crew with laboratories and quarters for civilian trials personnel. She spends much of her time at sea, conducting some 25 trials a year. Analysis of the data collected during trials reveals sources of radiated noise undetectable by other means; and allows the Navy to correct acoustic problems.

CENTER DETACHMENTS (CONTINUED)

PUGET SOUND DETACHMENT

BREMERTON, WA

The Center's detachment at Puget Sound Naval Shipyard was established in 1966 with the Hydrofoil Special Trials Unit. The Bremerton, Washington site was selected based on the close proximity to the builder, and now support contractor for maintenance and operation of the hydrofoil ship HIGH POINT (PCH-1). With the transfer of the Ship Silencing Evaluation Division to the Center, the Hydrofoil Trials group is a branch of the detachment reporting to the Ship Systems Integration Department, Advanced Naval Vehicle Division, Carderock.

The Ship Silencing Evaluation Division operates the Carr Inlet Acoustic Range (CIAR), in Puget Sound, and the Santa Cruz Acoustic Range Facility (SCARF) off Santa Barbara, California. The division conducts Naval Sea Systems Command sponsored acoustical trials on surface and subsurface ships, and conducts pre-deployment acoustical trials for Commander, Submarine Force, U.S. Pacific Fleet.

ACOUSTIC RESEARCH DETACHMENT

BAYVIEW, ID

The Center's Acoustic Research Detachment (ARD), Bayview, ID, was established on 31 October 1946 to support experiments in underwater acoustics at Lake Pend Oreille, Bayview, ID. The currently occupied buildings and grounds were acquired on deactivation of the Farragut Naval Training Center. Lake Pend Oreille provides a deep (1150 ft.), quiet body of water where a free-field ocean-like environment is available without the attendant problems and costs of open ocean operations. Unique experimental hardware and floating platforms have been developed to support a wide variety of R&D programs ranging from the measurement of flow induced boundary layer fluctuations on sonar domes to the calibrations of full-scale surface ship sonar transducers.

Detachment personnel supporting the experiments form a versatile resident core of highly skilled labor. They work closely with transient project scientists, engineers and technicians from the Center and other Navy and private organizations, to plan and conduct operations on the lake. The results obtained during past experiments have been extremely valuable to the Navy, especially in the area of submarine sonar dome development. Future plans include continuation of sonar dome development and submarine silencing and target strength reduction experiments using large-scale models, as well as increased emphasis on propulsor noise reduction. The Large Scale Vehicle (LSV), a large-scale structural model of the SSN-21 Class submarine, which will be delivered to Bayview in November 1987, will be utilized extensively in this research work.

PROGRAM WORK

NAVAL VEHICLES

The Center provides technological development and/or support in the following major program areas:

SUBMARINES: Resistance and powering, stability and control, propulsion, auxiliary machinery, electrical power generation and distribution, structures, signatures, silencing, radiated and self-noise measurement and predictions, survivability, materials, welding, propulsion and machinery materials, analytical and physical evaluative techniques, target strength reduction and marine tribology.

Emphasis on:
- TRIDENT
- SSN-688
- SSN-21 Design
- Advanced Conformal Submarine Acoustic Sensors (ACSAS)
- Submarine Mine Laying System

SURFACE SHIPS: Resistance and powering, seakeeping, stability and control, propulsion, auxiliary machinery, electrical power generation and distribution, structures, signatures, silencing, environmental protection, waste control, materials, fabrication processes, survivability, energy conservation, fuel availability, and marine tribology.

Emphasis on:
- CVNs
- DDG-80
- T-AGOS

ADVANCED VEHICLES: Coordination of research and exploratory development activities, technical support to the acquisition program, and developmental and operational testing.

Emphasis on:
- Landing Craft, Air Cushion (LCAC)
- Small Waterplane Area Twin Hull (SWATH) Ships
- Hydrofoil Ships
- Surface Effect Ships
- Submersibles

AIRCRAFT: Aerodynamics for all aircraft types. Particular focus on V/STOL and rotorcraft.

Emphasis on:
- F-14 Yaw Vane
- V-22 Osprey
- X-Wing
- National Aerospace Plane Program (NASP)

MARINE CORPS: Technology, innovative technology demonstrations, and demonstrated hardware components to reduce the weight and cost and improve the speed, survivability and performance of vehicles, especially assault amphibians.

Emphasis on:
- Amphibian Vehicles
- Lightweight Vehicles
- Armor

PROGRAM WORK (CONTINUED)

LOGISTICS

As the Navy's principal center for Naval logistics, DTRC is developing the technology base, system concepts, and systems needed to improve Navy and Marine Corps logistics, increase fleet readiness, and reduce associated costs and manpower. DTRC R&D efforts are concentrated in: logistic planning, management, control, communication, delivery and supply systems; maintenance, overhaul, and manufacturing; acquisition; data control and data bases; and Integrated Logistics Support (ILS).

WEAPON SYSTEM SUPPORT

Special program support in WEAPON SYSTEMS areas such as: towed systems, aerodynamics of missile/aircraft interfaces, and warhead effectiveness against ships and submarines.

MAJOR ACCOMPLISHMENTS

Each year, the Center increases the Navy's mission effectiveness. Acoustic silencing techniques and submarine trials continue significant noise reductions, thereby increasing the effectiveness of attack submarines, and lessening the vulnerability of strategic missile submarines. Hydrodynamic studies on models and fleet units have increased speeds and seakeeping abilities; structrual analyses, designs and tests have increased the strength and survivability of today's combatants. Development of computer based systems has improved the quality and reduced the cost of ship analysis, design, and construction. More reliable electrical and mechanical machinery extend on-station capabilities; new materials provide added strength, better protective qualities and less susceptibility to failure. The development of logistic methodologies, data bases, and support hardware systems has improved Navy and Marine Corps logistics and fleet readiness.

Nine of the most significant technical and managerial accomplishments achieved during the preceding two fiscal years are:

1) LARGE SCALE VEHICLE (LSV)

The Large Scale Vehicle (LSV) model was completed and will be delivered to the DTRC Acoustic Research Detachment in Bayview, Idaho in November 1987. The model will operate on Lake Pend Oreille, simulating full-scale submarine operations over a wide range of environmental conditions. The world's largest unmanned, free-swimming submersible is designed to handle the stresses of high-speed maneuvering, and is expected to play an important role in the development of the SSN-21 attack submarine propulsor.

2) FIRST USS OHIO CLASS SUSPENSION TEST

The first USS OHIO Class suspended acoustic trial was conducted at the DTRC Carr Inlet Acoustic Range (CIAR). This trial permitted extensive testing of all ship systems under a variety of operating conditions in order to assess their acoustic and vibrational characteristics. Extensive preparation was required to accommodate the ship at the range and to process the large volume of data acquired. The trial was a complete success and has resulted in an improved understanding of noise generation and transmission paths aboard USS OHIO Class submarines, and provided important information to the Fleet and to the SSN 21 design.

3) SURVIVABILITY

DTRC has made significant gains in ship and submarine survivability in the last year. Two portable smoke curtain prototypes proved so effective in reducing smoke spread and retarding fire growth, by limiting the amount of air flowing into the fire compartment, that they have already been issued to the FFG-7 Class ships. Eventually the smoke curtains will be issued to all surface ship combatants.

Another recent DTRC development which enhances survivability is the improved cable bulkhead penetration device. These devices can withstand a fire temperature of 2000 degrees F for one hour without allowing the flame to spread to the non-fire side of the bulkhead.

4) SHOCK TESTING AND ANALYSIS METHODS

DTRC conducted underwater explosion shock tests against the USS WHIDBEY ISLAND (LSD-41), USS MOBILE BAY (CG-53) and the USS THEODORE ROOSEVELT (CVN-71). General objectives of the ship shock qualification program include demonstrating the ability of the ship to conduct combat system operations during exposure to underwater shock. Also, shock test data is used to provide a basis for refinement of shock hardening

MAJOR ACCOMPLISHMENTS (CONTINUED)

criteria applicable to future ships. Specific objectives of the WHIDBEY ISLAND shock test series were to validate the shock hardening criteria and standards prescribed for LSD-41 Class ships and applying lessons learned in the areas of ship structure and equipment hardness to shock loading. Ship modifications will be applied to other fleet units and incorporated into future designs, enabling the Navy to optimize ship designs for maximum resistance to underwater explosions.

5) UNDEX/RED SNAPPER

Researchers from DTRC conducted a series of underwater explosion (UNDEX) tests against the newly completed large-scale submarine model, RED SNAPPER, during August/September 1986. Fourteen elastic and damaging tests were conducted on this model. The results validated the methodology being used by the Navy to estimate whipping response of modern submarines to proximity fuzed underwater weapons. RED SNAPPER was also used to demonstrate heavyweight torpedo warhead effectiveness to do structural damage.

6) LARGE CAVITATION CHANNEL

Groundbreaking ceremonies for DTRC's Large Cavitation Channel (LCC) were conducted 31 August 1987 at Presidents Island, Memphis, Tenn. The LCC will be used to more effectively solve future hydroacoustic and hydrodynamic problems before full-scale trials, the primary purpose being to facilitate noise reduction in submarine and ship propulsors. It will also enable the Navy to produce more efficient hull propulsor combinations and correct deficiencies in existing systems.

7) MARINE CORPS AUTOMOTIVE TEST RIG

The Center recently completed a significant step toward a high water-speed assault amphibian vehicle for the Marine Corps with the development of the Automotive Test Rig (ATR). The ATR incorporates a number of advanced features — computer controlled hydrostatic drive, retractable hydropneumatic suspension, two-speed final drives, and a light weight band track — in a vehicle capable of satisfying a number of missions. As configured, the ATR mounts an integrated remotely controlled, unmanned weapon station with a 25mm chain gun and a coaxial 7.62mm machine gun.

8) ENHANCED CARRIER MAGAZINE PROTECTION

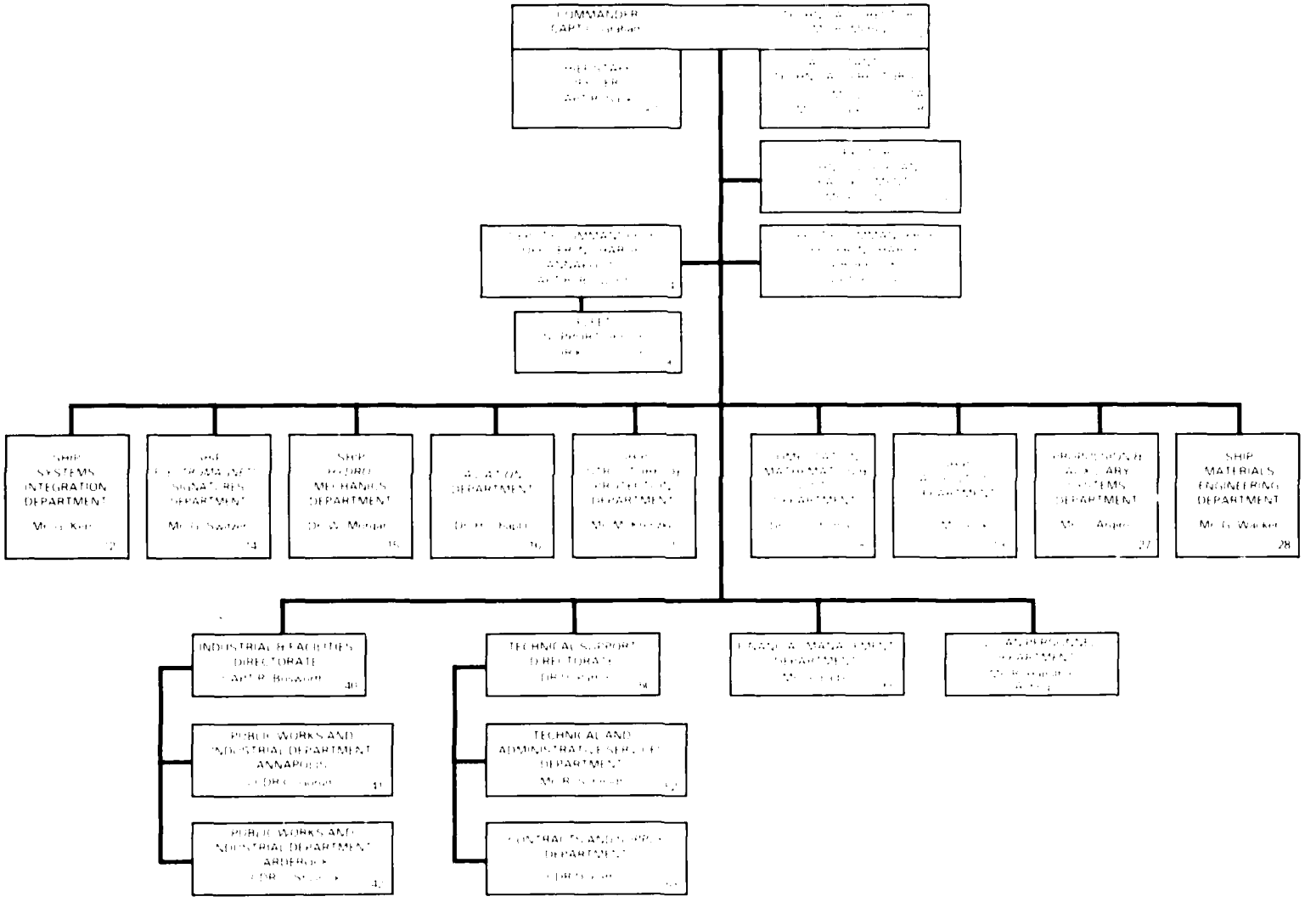
The Center's efforts to find means of protecting large magazines on aircraft carriers from the effects of missile and underbottom torpedo attacks have resulted in several types of novel and effective spaced armor systems, in computerized armor design methods and in theoretical methods for predicting ship bottom response to explosions. New armor systems resulting from the Center's efforts have been incorporated in CVN-71, 72 and 73 and will be backfitted on the CV-63 and CVN-69.

9) COMPOSITE (FIBER REINFORCED PLASTICS) STRUCTURES

The Center has demonstrated the feasibility of using fiber reinforced plastic composites for submarine control surfaces and air flasks. Both composite applications offer a 60-70 percent weight savings over current steel structures without sacrificing performance on static, fatigue and shock load tests or ballistic penetration behavior.

DTRC

DAVID TAYLOR RESEARCH CENTER



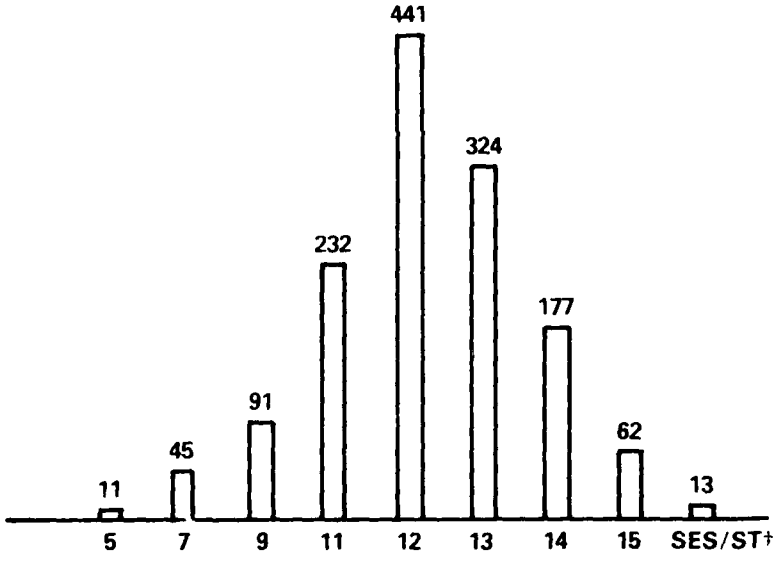
30 SEPTEMBER 1987

DTRC

PERSONNEL

TOTAL ON BOARD	TOTAL MILITARY	TOTAL CIVILIAN	FTP*	TPTI**	FTP UNGRADED	FTP GRADED
2857	65	2792	2684	108	398	2286

FULL TIME PERMANENT SCIENTISTS AND ENGINEERS BY GRADE



FULL TIME PERMANENT GRADED PERSONNEL BY DISCIPLINE

ADMINISTRATIVE	255
TECHNICIANS	331
SCIENTISTS & ENGINEERS	1396
OTHER (CLERICAL, GUARDS, ETC)	304
MECHANICAL ENGR	411
NAVAL ARCHITECT	266
PHYSICIST	118
STRUCTURAL ENGR	19
ELECTRONICS ENGR	121
MATHEMATICIAN	36
GENERAL ENGR	84
AEROSPACE ENGR	52
ELECTRICAL ENGR	74
CHEMICAL ENGR	38
CHEMIST	28
METALLURGIST	22
MATERIALS ENGR	44
OTHER	83
TOTAL	1396

ASSIGNED END-STRENGTH
2768

MILITARY ALLOWANCE:
OFFICER 21 ENLISTED 44

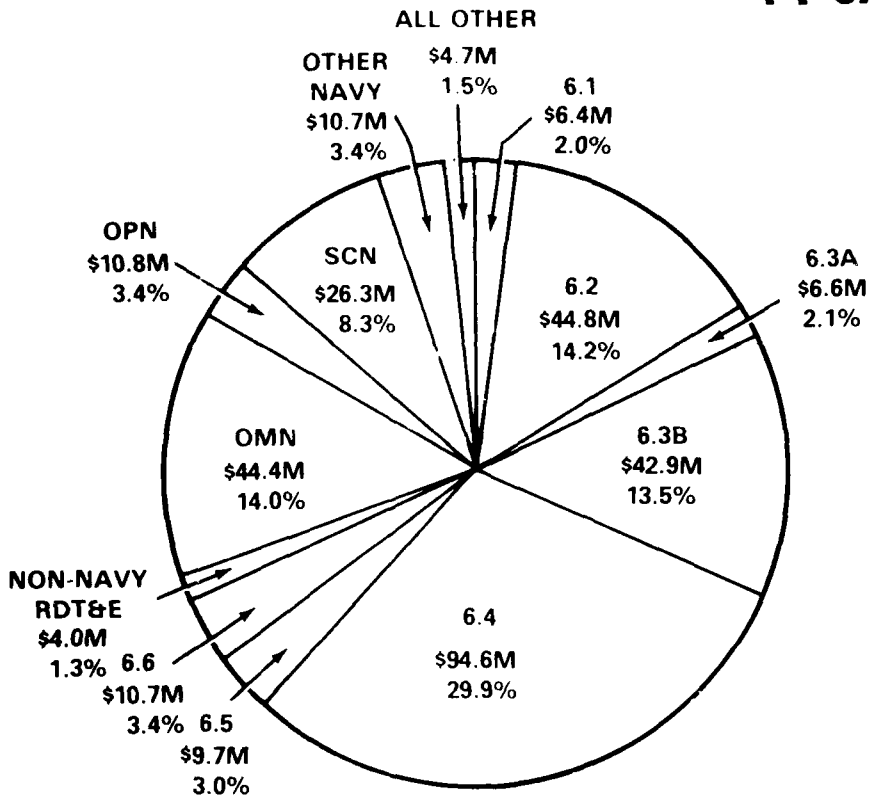
* FULL TIME PERMANENT
** TEMPORARY, PART-TIME, INTERMITTENT (SUMMER EMPLOYEES EXCLUDED)
† SENIOR EXECUTIVE SERVICE/STATUTORY

30 SEPTEMBER 1987

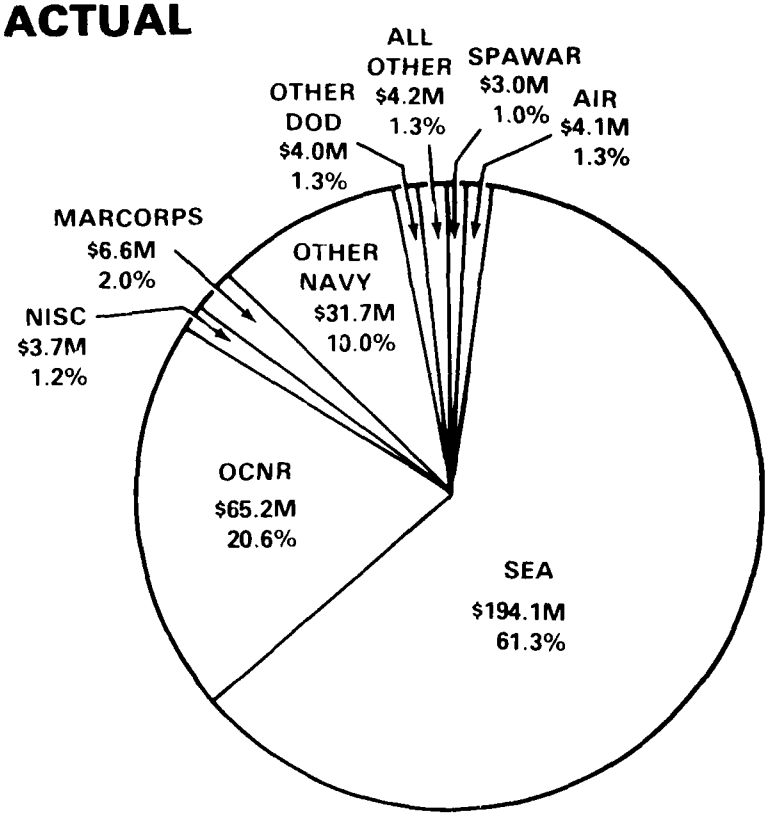
DTRC

*(NOR – NEW ORDERS RECEIVED)

SOURCE OF FUNDS
FY 87 ACTUAL



FUNDING BY APPROPRIATION
$316.6M



FUNDING BY SPONSOR
$316.6M

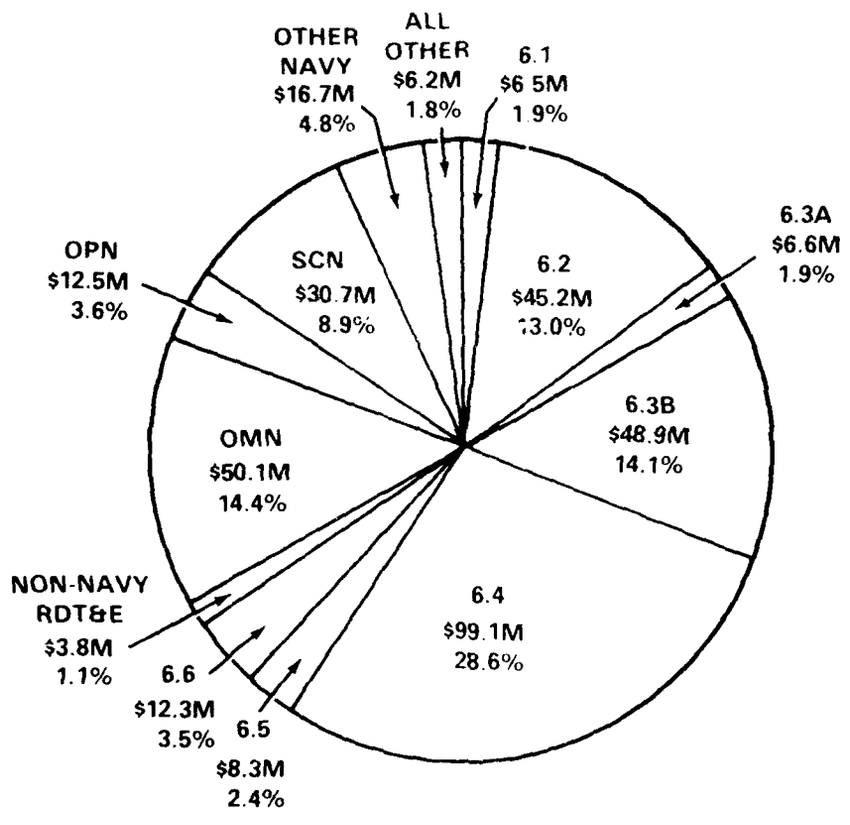
SOURCE OF DATA: LABORATORY
PROJECT LISTING – 1/88

30 SEPTEMBER 1987

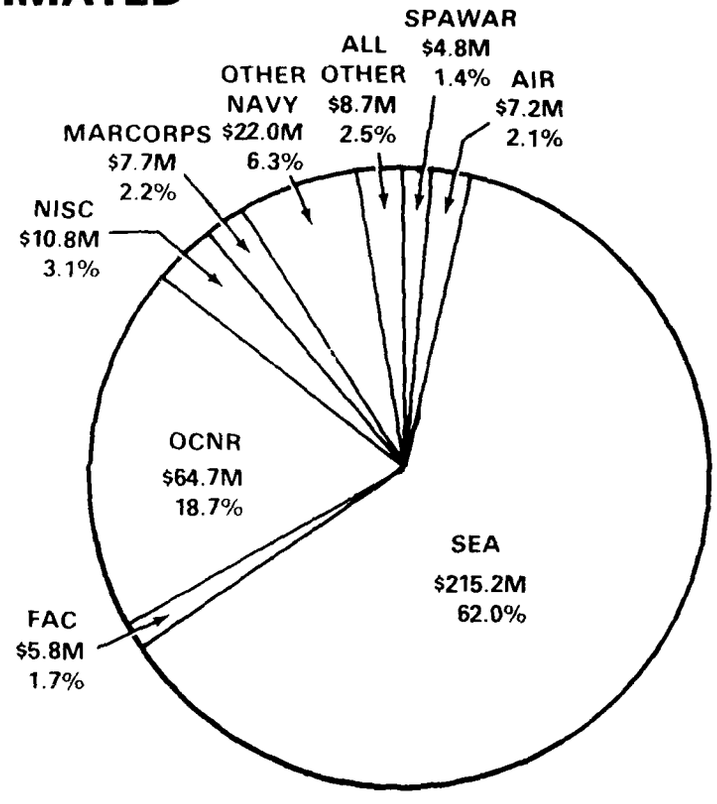
DTRC

SOURCE OF FUNDS
FY 88 ESTIMATED

*(NOR – NEW ORDERS RECEIVED)



FUNDING BY APPROPRIATION
$346.9M



FUNDING BY SPONSOR
$346.9M

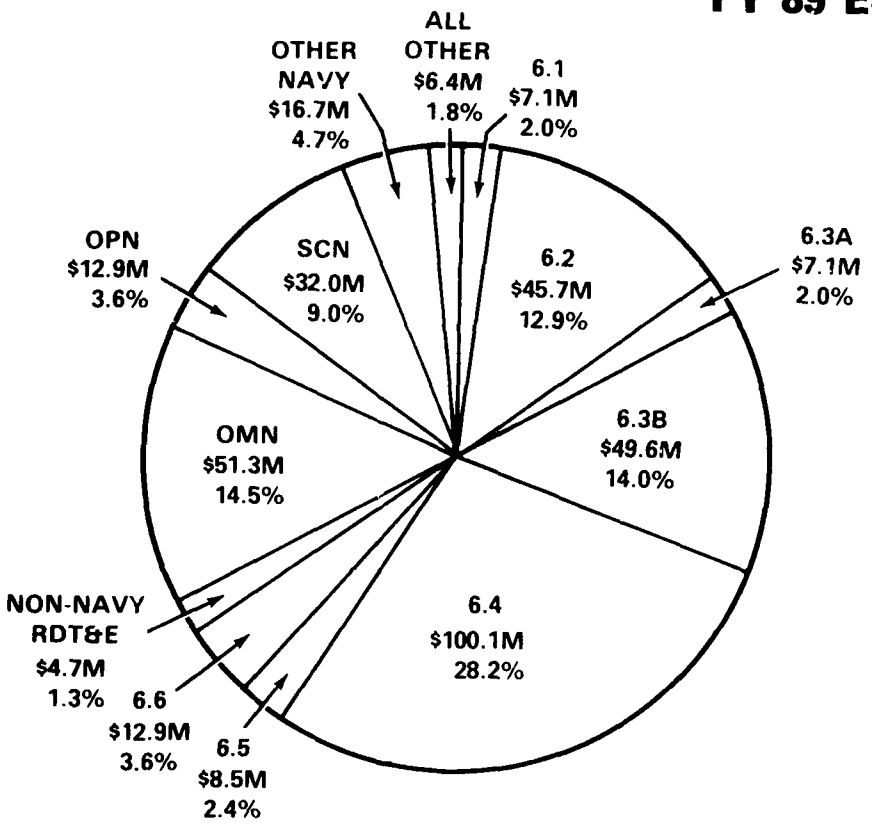
SOURCE OF DATA: LABORATORY
PROJECT LISTING – 1/88

30 SEPTEMBER 1987

DTRC

*(NOR – NEW ORDERS RECEIVED)

SOURCE OF FUNDS
FY 89 ESTIMATED



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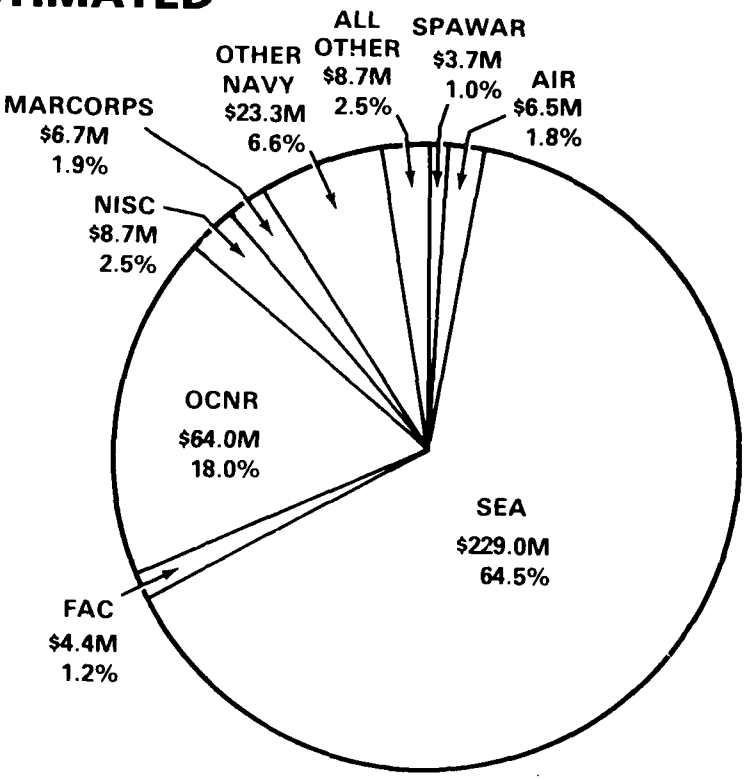
$355.0M



FUNDING BY SPONSOR
$355.0M

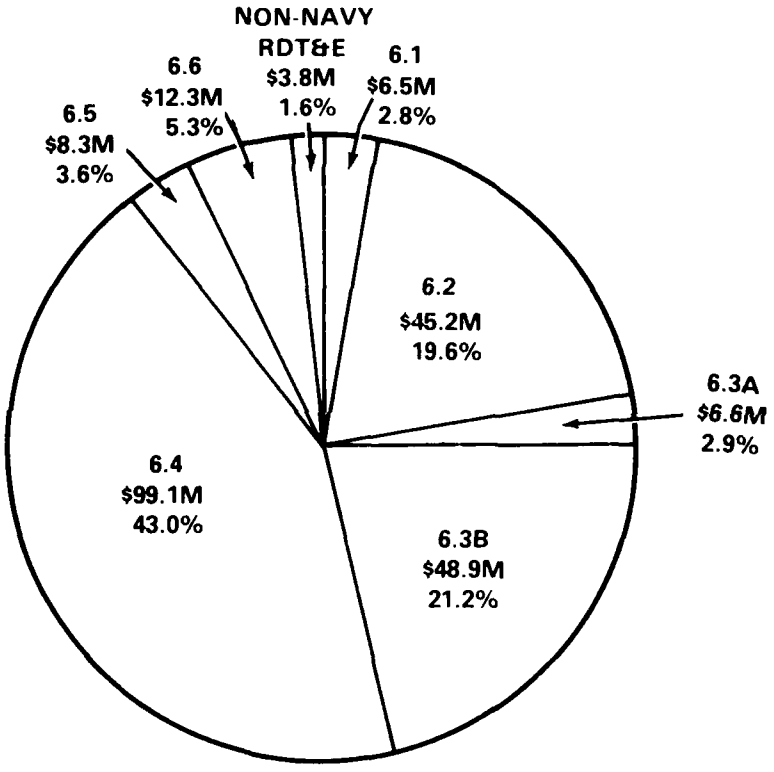
30 SEPTEMBER 1987

SOURCE OF DATA: LABORATORY PROJECT LISTING – 1/88 (REVISED)

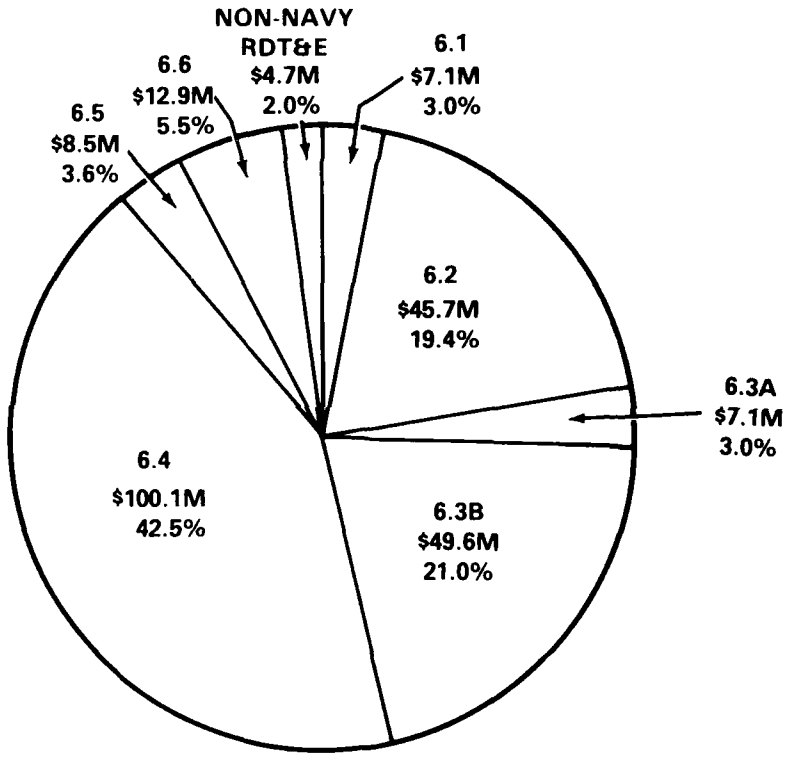
DTRC

*(NOR – NEW ORDERS RECEIVED)

RDT&E FUNDS BY CATEGORY



FY 1988 ESTIMATED
$230.7M



FY 1989 ESTIMATED
$235.7M

SOURCE OF DATA: LABORATORY
PROJECT LISTING – 1/88

30 SEPTEMBER 1987

DTRC

FUNDS BY CATEGORY AND TYPE
(NOR) $M

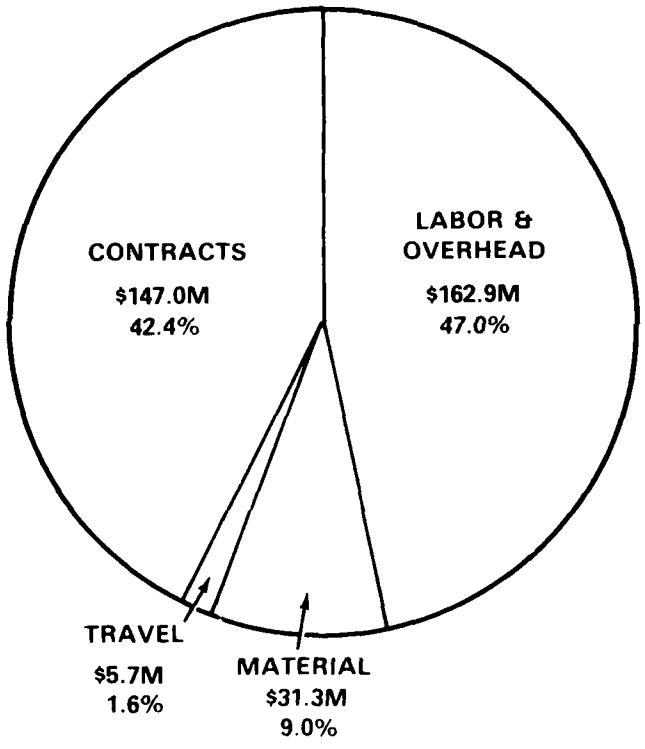
CATEGORIES & TYPE	FY 1987			FY 1988			FY 1989		
	$M ACT.	% OF RDT&E	% OF TOTAL	$M EST.	% OF RDT&E	% OF TOTAL	$M EST.	% OF RDT&E	% OF TOTAL
RDT&E, N (CATEGORY)									
6.1 RESEARCH	6.4	2.9	2.0	6.5	2.8	1.9	7.1	3.0	2.0
6.2 EXPLORATORY DEVELOPMENT	44.8	20.4	14.2	45.2	19.6	13.0	45.7	19.4	12.9
6.3a ADVANCED TECHNOLOGY DEVELOPMENT	6.6	3.0	2.1	6.6	2.9	1.9	7.1	3.0	2.0
SUBTOTAL	57.8	26.3	18.3	58.3	25.3	16.8	59.9	25.4	16.9
6.3b ADVANCED DEVELOPMENT	42.9	19.5	13.5	48.9	21.2	14.1	49.6	21.0	14.0
6.4 ENGINEERING DEVELOPMENT	94.6	43.1	29.9	99.1	43.0	28.6	100.1	42.5	28.2
6.5 MANAGEMENT AND SUPPORT	9.7	4.4	3.0	8.3	3.6	2.4	8.5	3.6	2.4
6.6 OPERATIONAL SYSTEMS DEVELOPMENT	10.7	4.9	3.4	12.3	5.3	3.5	12.9	5.5	3.6
RDT&E, N SUBTOTAL	215.7	98.2	68.1	226.9	98.4	65.4	231.0	98.0	65.1
OTHER RDT&E	4.0	1.8	1.3	3.8	1 6	1.1	4.7	2.0	1.3
TOTAL RDT&E	219.7	100.0	69.4	230.7	100.0	66.5	235.7	100.0	66.4
OTHER APPROPRIATIONS									
(O&MN) OPERATION & MAINTENANCE, NAVY	44.4		14.0	50.1		14.4	51.3		14.5
(OPN) OTHER PROCUREMENT, NAVY	10.8		3.4	12.5		3.6	12.9		3.6
(SCN) SHIPBUILDING & CONVERSION, NAVY	26.3		8.3	30.7		8.9	32.0		9.0
OTHER	15.4		4.9	22.9		6.6	23.1		6.5
OTHER APPROPRIATIONS SUBTOTAL	96.9		30.6	116.2		33.5	119.3		33.6
TOTAL	316.6		100.0	346.9		100.0	355.0		100.0

30 SEPTEMBER 1987

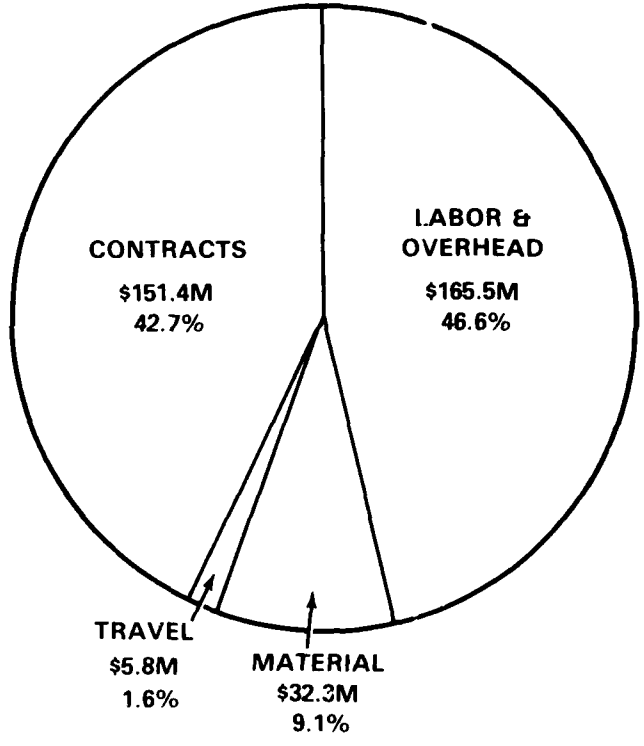
SOURCE OF DATA: LABORATORY PROJECT LISTING – 1/88

DTRC

DISTRIBUTION OF FUNDS*



FY 1988 ESTIMATED



FY 1989 ESTIMATED

SOURCE OF DATA: FY 89 A-11 BUDGET
*INCLUDES ACP SURCHARGE

30 SEPTEMBER 1987

DTRC

LEADERSHIP ASSIGNMENTS

RESPONSIBLE FOR NAVY-WIDE LEADERSHIP IN:

a. Surface and subsurface vehicles.

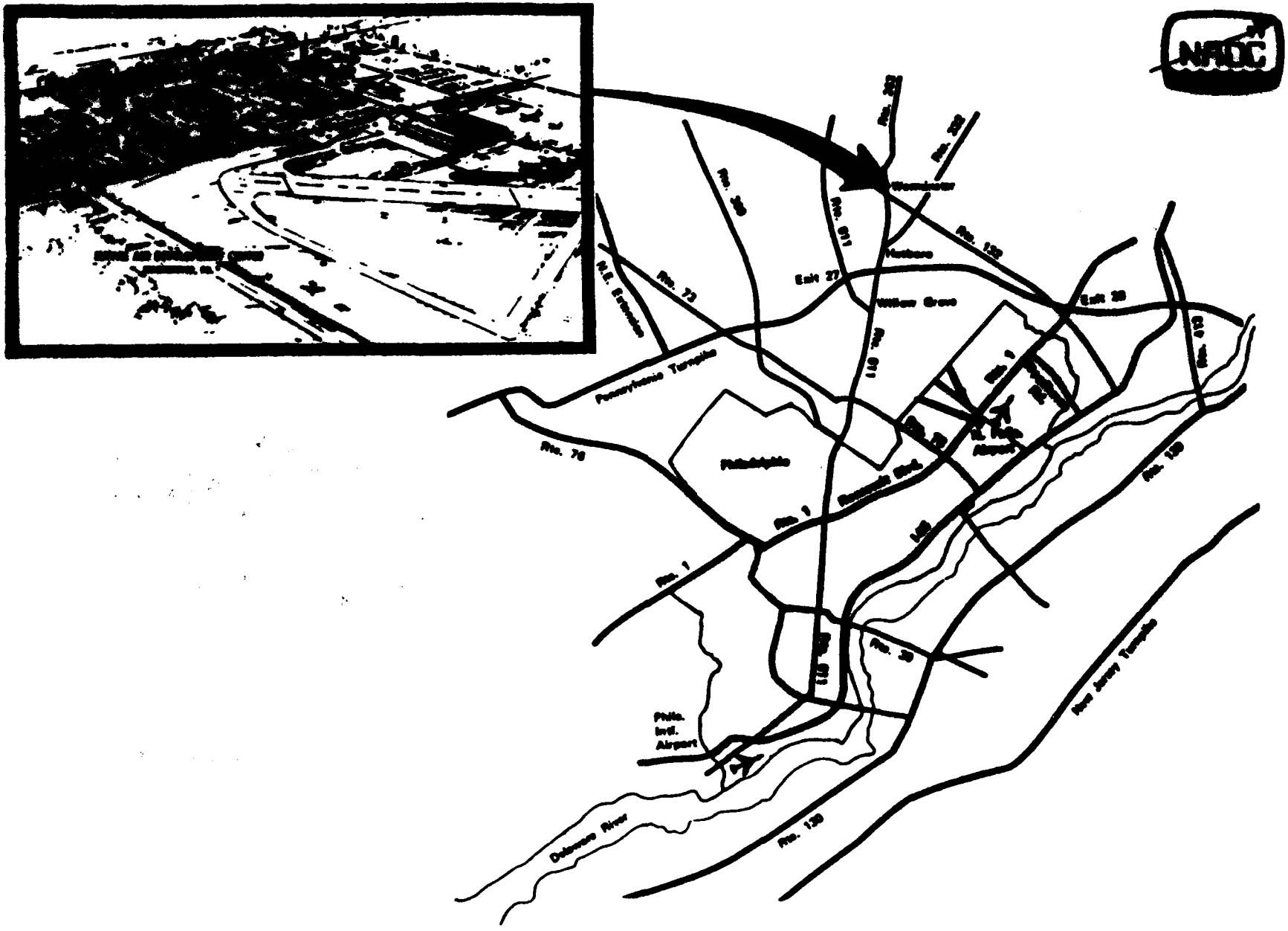
b. Logistics support systems technology.

c. Experimental aircraft aerodynamics.

REF: NAVMATINST 5450.27C DATED 1 AUGUST 1983

30 SEPTEMBER 1987

NAVAL AIR DEVELOPMENT CENTER BRIEF



30 SEPTEMBER 1987

MISSION

TO BE THE PRINCIPAL NAVY RESEARCH, DEVELOPMENT, TEST, AND EVALUATION CENTER FOR NAVAL AIRCRAFT SYSTEMS, LESS AIRCRAFT-LAUNCHED WEAPON SYSTEMS

30 SEPTEMBER 1987

INTRODUCTION TO THE NAVAL AIR DEVELOPMENT CENTER

The Naval Air Development Center (NAVAIRDEVCEN), established in 1944, is one of the Navy's prime Research, Development, Test, and Evaluation (RDT&E) Centers, operating under the direction of the Space and Naval Warfare Systems Command. Located 23 miles north of downtown Philadelphia, the Center occupies 824.3 acres, including over 1 million square feet of office and laboratory space and an airfield suitable for all types of naval aviation vehicles. The Center has two remote sites for testing and experimentation. The first is a flooded, former quarry situated on 14.7 acres in Oreland, Pennsylvania, a few miles west of the NAVAIRDEVCEN, and used primarily for acoustics development. The second is a small detachment at Key West, Florida, where considerable developmental testing and technical evaluation are conducted.

As of 30 September 1987, the NAVAIRDEVCEN employed 234 military and 2668 full-time permanent civilians including 1602 scientists and engineers. Total revenue for FY-1988 will be approximately $385 million with over 50 percent of the funding coming from the Naval Air Systems Command.

The Center is divided into three Warfare Systems Departments and four Engineering and Technology Departments:

ANTISUBMARINE WARFARE SYSTEMS DEPARTMENT (ASWSD) — Is responsible for the technical performance, schedule and cost control for all assigned antisubmarine warfare (ASW) programs/projects/tasks and related support systems, such as software development and generation facilities. The department is responsible for providing a full range of ASW program/project management, system engineering, warfare analysis, and advanced concepts functions to execute the assigned tasking. The department is also responsible for developing a strategic plan, marketing applicable products, providing guidance to Engineering and Technology Departments (E&TD) for requirements to meet future operational system needs, and integrating technology developments into present and future systems.

TACTICAL AIR SYSTEMS DEPARTMENT (TASD) — Provides the technical performance, schedule and cost control for Anti-Air Warfare, Anti-Surface Ship Warfare, Strike/Warfare, Reconnaissance Systems, and related tactical support systems, such as targets, remotely piloted vehicles, tankers and trainers. The department provides a full range of TAS program/project management, system engineering, warfare analysis, and advanced concepts functions to execute the assigned tasking. Specific project responsibilities include A-6F, F-14A/D, F/A-18 (R), AV-8B, Tactical Aircrew Combat Training Systems, Advanced Tactical Aircraft, V-22, and other tactical platforms currently under going development, test/evaluation, fleet introduction and support.

BATTLE FORCE SYSTEMS DEPARTMENT (BFSD) — Provides a single point of accountability for the technical performance, schedule, and cost control for all tasks related to Battle Force architecture and systems. Specific project responsibilities include Central Development Agency, TACAMO, Joint Tactical Information Distribution System, Lighter-Than-Air, Battle Force Command and Control, Advanced Tactical Support Aircraft (ATSA), Battle Force Remotely Piloted Vehicles, Forward Pass, Over-The-Horizon and third-party targeting.

COMMUNICATION NAVIGATION TECHNOLOGY DEPARTMENT (CNTD) — Conducts research and development of navigation systems for all Naval platforms and communication systems for all Naval Air platforms, as well as command and control architectures, information exchange systems, and integration concepts for Naval tactical air platforms. Provides advisory and technical management services in areas of aircraft, ship, and submarine navigation.

MISSION AVIONICS TECHNOLOGY DEPARTMENT (MATD) — Researches, designs, and develops airborne sensors, subsystems, and components for Anti-Air Warfare, Anti-Submarine Warfare, Anti-Ship Warfare, and Ocean Surveillance. Involves technologies for the surveillance and targeting of airborne, surface and subsurface targets, and employs countermeasures technologies for countering target actions to prevent surveillance and for the protection of the surveillance aircraft. Provides technical support to other Centers, Naval Systems Commands, and Naval Field Activities engaged in RDT&E, and to operating forces. Technical support includes technology base and

INTRODUCTION TO THE NAVAL AIR DEVELOPMENT CENTER (cont.)

systems/subsystems development, test and evaluation, and fleet equipment introduction/employment.

AIR VEHICLE AND CREW SYSTEMS TECHNOLOGY DEPARTMENT (AVCSTD) — Provides a comprehensive and coordinated program in all areas of aircraft and crew systems research, design, development, testing, acquisition and fleet support for the Navy. This includes technical and engineering leadership in air vehicle design and performance studies and evaluation, aerodynamics and propulsion, advanced aircraft structures concepts and service life prediction methods, development and integration of aircraft subsystems, materials science and advanced materials engineering, human factors technology and methodology for all aspects of operator/maintenance procedures and cockpit/crew station design/life sciences. Provides engineering in the development of life support, escape, protective, survival and rescue equipment. The application of crew systems technology to all Navy platforms ensures appropriate and timely consideration of the human element in airborne weapon systems.

SYSTEMS AND SOFTWARE TECHNOLOGY DEPARTMENT (SSTD) — Performs systems and software RTD&E for Navy airborne systems. Responsibilities include tasking in all phases of the software life-cycle, from research through support for deployed systems. Provides RDT&E for artificial intelligence applications, signal processing and simulation software. Provides costing, reliability and maintainability expertise. Provides operational, system test and support software for Navy air platforms.

FACILITIES

The NAVAIRDEVCEN is located in Warminster, Pennsylvania, 23 miles north of center city Philadelphia. Total acreage, building usage, and capital investment are as follows:

LAND:	
OWNED	839 acres
BUILDINGS:	
RDT&E	860,700 sq. ft.
ADMINISTRATIVE	92,500 sq. ft.
OTHER	451,300 (Excl. housing)
ACQUISITION COSTS:	
REAL PROPERTY	$44.7 Million
EQUIPMENT	$124.0 Million

MAJOR FACILITIES INCLUDE:

VS FACILITY — The S-3 System Readiness Facility and System Integration Laboratory areas provide developers with facilities for testing operational or training software and evaluating hardware improvements prior to aircraft installation. Fleet issues are produced in the Software Generation Facility. Configuration Control and Documentation Management sections distribute all software and publications required for fleet use. This facility, through the use of simulation equipment, provides software life cycle support for the S-3 VIKING, the Navy's carrier-based, fixed-wing ASW aircraft.

P-3C FACILITY — This facility, currently consisting of a Module Test Bed, the Software Development Facility, and the Program Generation Center, provides for the development and testing of all operational and system test software programs for P-3C Non-Update, Update I, Update II, Update III, and Foreign Military Sales aircraft. The facility supports the introduction of new equipment and software through a reconfigurable set of mission avionics capable of exact representation of any current P-3C configuration. As the P-3C System Software Support Activity (SSSA), the facility supports the delivery of all P-3C fleet issue operational and system test software. Additionally, the facility's functional capability is being expanded to incorporate the new technology Update IV laboratory consisting of a Software Development Facility and a System Avionics Integration Laboratory.

30 SEPTEMBER 1987

CARRIER ANTISUBMARINE WARFARE MODULE (CV-ASWM) — This facility, through the use of simulation equipment, provides developmental software for the ASWM, which is part of the Advanced Combat Directions System (ACDS) aboard aircraft carriers. This uses actual Q-21 display hardware and taped acoustic inputs. It develops fleet issue software for deployed systems, the Integrated Combat System Test Facility and the Fleet Combat Training Center, Atlantic. This facility contains both typical shipboard and developmental equipment, along with test benches for logistic support. Actual S-3 flight data can be processed to provide replay or printout of flight information. With acoustic processing, complete missions can be simulated.

ANTENNA TEST FACILITY — Several major components comprise the 30-acre Antenna Test Facility. The Electromagnetic Measurements Range provides an accurate antenna and/or antenna/radome measurement capability. The equipment provides automatic measurement of gain and radiation patterns from VHF through microwave frequencies. Maximum separation between the 42-ft. mobile transmit tower and the receiving antenna is limited to 1,500 ft.

A nearby building houses the Anechoic Chamber (30 ft. by 100 ft.) which provides an RF anechoic environment for the test and evaluation of VHF, UHF, and microwave antennas.

Another component, the Rain Erosion Test Facility, is used to measure the resistance to rain erosion of radome materials. Material samples can be evaluated at velocities up to Mach 2.09 in a simulated 1-inch-per-hour rain field for extended periods of time. The facility can be used to conduct research in the phenomenon of rain erosion damage and to qualify materials for use in the fabrication of radomes.

SONAR DEVELOPMENT SIMULATION FACILITIES — These facilities are the Navy's primary facilities dedicated to the development and evaluation of advanced systems. The ocean environment can be simulated under laboratory conditions and controls in order to develop and evaluate the hydromechanical and acoustical performance of sonobuoy systems and subassemblies. The Open Water Facility consists of a floating platform located in a body of water 900 ft. long by 360 ft. wide and 65 ft.

FACILITIES (cont.)

deep. Total simulation of the ocean environment and underwater targets can be achieved using calibrated sound sources, an acoustically transparent pressure vessel, a vertical motion sea-state simulator, and a 100-ft. tow rail. For visual and photographic observation of sonobuoy component performance under simulated ocean conditions, a 60- ft. deep underwater viewing tower is available with observation platforms and viewing ports at 10-ft. intervals. The Gradient Room Facility, a sound-insulated 30-ft. x 20-ft. enclosure, houses three specialized acoustic calibrators for evaluating the acoustic performance of pressure and pressure gradient sensors and linear arrays over simulated temperature and hydrostatic pressure conditions. The Tank Facility consists of a 26-ft. diameter wooden tank equipped with a rotating arm for continuous in situ flow simulation and two rectangular plexiglas tanks equipped with a low velocity tow mechanism for basic hydrodynamic studies. Both Plexiglas tanks are equipped for flow visualization using the hydrogen bubble technique.

NAVAIRDEVCEN DETACHMENT, KEY WEST, FL — This year-round quick-reaction test facility is maintained to support the Center's mission by providing access to deep and shallow water environments for evaluation of developmental system parameters. The detachment, hosted by the Naval Air Station, Key West, maintains a 1,000-ft. pier, 10,000 sq. ft. of laboratory and machine shop facilities, and six vessels (135-ft. LCU, 74-ft. LCM-8, one 50-ft. and three 16-ft. work boats). The three larger vessels are specially equipped with a combination of aircraft equipments, standard laboratory and tape recording equipments, and containerized laboratory vans in support of special programs. The detachment is staffed with four civilians and is augmented with contractor boat support personnel as required. The geography, geology, and control of airspace and waterways provide many advantages for ASW operations. Programs are supported by aircraft assigned to the NAVAIRDEVCEN and through fleet resources.

CENTRAL COMPUTER SYSTEM (CCS) — The CCS is a general purpose, scientific and engineering computing facility designed to support local and remote batch, local and remote interactive, and special purpose simulation. The complex consists of a CDC 6600, a CDC Cyber 730, a CDC Cyber 175, two CDC Cyber 760's, two DEC VAX 11/780 digital computers, five EAI 8800 analog computers, display subsystems, extensive hybrid linkage, including real-time man-in-the loop simulation interface equipment, special purpose function generation, signal processing equipment, and the latest addition, a Cyberplus/Micro-AFP. The specially designed electronic interfaces integrated into the digital computers and the specially designed software provide a unique facility for the real-time man-in-the-loop simulation. The total system gives this Center one of the most capable scientific computer/simulation facilities in the defense establishment.

The CCS provides computational services for the Center's engineering and scientific staff; computational/simulation system for the Center's real-time-man-in-the-loop simulation laboratory; and fleet support data processing and life-cycle support of combat weapon systems. This includes the support of the NAVAIRDEVCEN Facility for Automated Software Production (FASP) throughout the Center and across the United States.

INERTIAL NAVIGATION FACILITY — The NAVAIRDEVCEN is unique within the Navy because its navigation responsibilities cover the spectrum of navigation techniques, systems, and instruments for all naval platforms and applications. A 155-ft. diameter building provides the unique environment required for evaluation of highly precise state-of-the-art inertial components such as ring laser gyros, strapdown accelerometers, single-degree and two-degree-of-freedom gas bearing gyros, dual electrically suspended gyros, and electromagnetic accelerometers required for basic motion sensing and inertial navigation systems. The Inertial Navigation Facility was designed to minimize man-made disturbances in the bedrock beneath the facility. Surveys have indicated that the facility location is one of the most seismically quiet spots in the continental United States. Granite test piers, isolated from the floor, are bonded to bedrock to achieve a low-vibration level and long-term positional stability required for inertial instrument developments. Inertial gyro test tables and dividing heads used with both gyros and accelerometers are mounted on the isolated granite piers. Horizontal and vertical seismic disturbances in the piers are monitored by a

FACILITIES (cont.)

seismograph. Direct sighting of Polaris, the North Star, is possible from the pier area to precisely align inertial gyro test tables with the earth's axis of rotation.

SHIPS MOTION SIMULATION FACILITY — This facility consists of two Scorsby test stands which are capable of simulating ship motions experienced at sea. The facility permits navigation system research and development, exploration of advanced system requirements and controlled diagnostic investigation of inertial navigation systems without lengthy and costly at-sea testing. The Scorsby test stands contain mounting tables 4 ft. in diameter on which equipment weighing up to 4,000 pounds can be mounted and subjected to roll, pitch, and yaw motions simultaneously. One of the test stands is enclosed within an environmental chamber which provides for changes in ambient temperature and humidity.

DYNAMIC FLIGHT SIMULATOR (DFS) — The DFS is the world's only full system pilot controlled, total G-Force simulator and is used to evaluate new concepts in crew station design, crew equipment, restraining systems, seating configurations, displays, controls, and pilot procedures in the G-Force environment in which they are to be used.

The DFS capabilities include the following equipment and subsystems: (1) multipurpose cockpit crewstation; (2) full-color, day brightness, real-world visual display system; (3) fiber optic data transmission system linking the simulator to the Center's Central Computer System; (4) local minicomputer and microprocessor systems; (5) active cockpit instrumentation and multi-purpose displays; and (6) simulated stick/rudder control loader system. The DFS has the capability of modeling any aircraft, and because of the flexibility of its software, can easily be changed from one aircraft configuration to another without major reprogramming. Also, the software permits inputs of mass, engine, or aerodynamic asymmetries as required by the experimental scenario.

The centrifuge arm is 50 ft. long, producing a maximum of 40 G's with a 1,000-pound payload and is capable of a maximum controllable onset rate of 10 G/sec. The gondola, a 10-ft. sphere suspended in a controllable two gimbal system, is temperature controlled, and can simulate a pressure altitude of 125,000 ft. while operating at 20 G's.

STRUCTURAL TEST FACILITY — The NAVAIRDEVCEN has the only capability within the Navy to perform structural testing, both static and fatigue, of aircraft structural specimens. These specimens range in size and complexity from small coupons and structural elements for research or design data generation purposes, through major subassemblies and full-scale structural components for design concept verification, to complete aircraft for service life extension programs. Test loads are applied by electronically programmed servo-controlled electro-hydraulic actuators, which may be used singly as individual test machines for simple element or coupon tests, or in several separately programmed groups for complex sections of aircraft structure. Various environmental conditions can be simulated, either for specimen conditioning purposes or during testing, including high and low temperatures, moisture and corrosive effects, low-velocity impact, vibration, and internal pressurization. Load, strain, deflection, and temperature data are monitored by a variety of recording devices including a multichannel, high-speed computerized data-acquisition system with on-line data reduction and graphical output capability. A full spectrum of laboratory services is available in support of structural testing, including high-speed and conventional photography, videotape playback, on-site nondestructive inspection and acoustic-emission monitoring, and a variety of experimental stress-analysis techniques.

GEORGE TSAPARAS DEVELOPMENT LABORATORY — This facility is a laboratory complex consisting of five dedicated laboratories in which RDT&E is performed for electrics, hydraulics, fluidics, flight controls and armament. Adjacent to these laboratories is an integration facility which contains a full-scale operational aircraft mock-up using the TA-7C as its baseline. All of the vehicle related technologies can be integrated into the mock-up for system evaluation and validation. Serving the integration facility is a fully equipped system software configuration control center which has a direct link to the NAVAIRDEVCEN Central Computer complex. The mock-up can be reconfigured to simulate vehicle systems for single-engine or multi-engine aircraft. This can be accomplished with the four-generator drive systems used for electric power

FACILITIES (cont.)

system evaluations. The generator drives are computer controlled and can be programmed to simulate mission scenarios in terms of engine speed and acceleration rates. The laboratory complex is interconnected with other Center integration facilities via digital multiplex and video buses.

VERTICAL DECELERATOR — This facility is a 150-ft. high structure with a 10-ft. by 10-ft. drop cart which free falls into a series of expendable metal bending arrestment straps. An entire range of deceleration from 5 G's to 100 G's can be produced. It has a maximum free-fall velocity of 85-ft./sec. and a platform payload of 1,000 pounds. Onboard high-speed photography and performance measuring instrumentation are available. This facility has been used with live test volunteers for deceleration up to 10 G's.

EJECTION SEAT TOWER — The Escape Systems Facility is a 150-ft. tower, inclined and supported 20 degrees from the vertical. It contains a shuttle whose acceleration is controlled by modifying propellant and catapult internal volumes. Accelerations up to 30 G's and rates of onset up to 500 G's/sec. are possible with the tower. Live subjects and anthropomorphic dummies are used to evaluate reactions, physiological acceptance for G onset rate and G tolerance, crew station accommodation, and clearances of aircraft ejection seats. This facility is also used for structural evaluations and qualification of escape systems and components.

FULL-SCALE AIRCRAFT TEST FACILITY — This facility consists of a three-story building supporting a full-size aircraft and a transmit tower. It is designed specifically to evaluate antennas and avionic systems on full-size aircraft. Presently, an F/A-18 aircraft is being used, but other aircraft can be used as required. The aircraft is mounted on a two-axis positioner, 35 ft. above ground level on top of the building, which is used as the receive end of the facility. A transmit tower, 40 ft. in height, can be located at distances of up to 4,500 ft. from the aircraft. Precision antenna pattern instrumentation equipment for the facility is located inside the receiver building directly under the aircraft.

The facility can be used to evaluate the effects of aircraft fuselage and stores on electronic countermeasures pod-mounted antennas, direction finding antenna systems, communication antennas, adaptive array antennas, and antennas used with active jamming systems. Highly accurate (within 1 db absolute amplitude and 0.1 degree angular position) data can be rapidly measured, recorded, and evaluated. Deficiencies can be discovered and antenna improvements implemented without expensive flight qualification and evaluation. Also, antenna-to-antenna isolation studies for inter and intra-system antennas can be performed using the facility. The facility can further be used to measure antenna radiation patterns, voltage standing wave ratio and gain, as well as to investigate airframe effects on antenna patterns. Tests of avionic systems, such as communication and electronic warfare equipment, can be achieved by simulating various desired jamming signal sources and monitoring appropriate systems outputs.

LIGHT AIRBORNE MULTIPURPOSE SYSTEM (LAMPS) FACILITY — This facility provides for the development and verification of LAMPS MK-III air system mission and system test software. The facility supports integration of LAMPS avionics and is capable of simulating in software the outputs and inputs of items of LAMPS MK-III avionics, as well as interacting with the avionics hardware. The facility contains an Integration Test Bed, which is a complete set of SH-60B avionics with appropriate stimulation via software inputs, to completely operate the aircraft functions. The Life Cycle Support (LCS) facility performs software support for the SH-60B, including both operational and system test program. The LCS facility can verify integration problems and trouble-shoot all the interfaces in the system.

ADVANCED SIGNAL PROCESSOR (ASP) LABORATORY — This facility provides operational and diagnostic software development for the ASP AN/UYS-1. The facility has a full set of AN/UYS-1 processing equipment together with appropriate displays and user-type controls to allow full exploitation of standard and developing acoustic algorithms. An acoustic simulator and a VAX 11/780 computer enable a completely integrated environment to be established. Compiling capabilities employ

FACILITIES (cont.)

the Center's Central Computer System and FASP software which are accessible to remote users. The ASP Laboratory supports processing and diagnostics for the current acoustic processor mode in Navy and Air Force platforms. Solutions to common user problems related to algorithm application, timing, and integration are provided. Configuration control for the ASP systems is maintained in this facility.

ADVANCED SYNERGISTIC SYSTEM ENGINEERING TECHNOLOGY (ASSET) LABORATORY — This laboratory provides for the transition of technologies from exploratory and advanced development stages to use on advanced platforms. ASSET assists platform programs in their concept formulation and definition phases. The ASSET Laboratory has an advanced system architecture, advanced integration technology, and distributed processing system in which advanced technology products can be integrated, demonstrated, and evaluated. The system contains multiplex and system test stations and associated software for testing and reducing data. A universal controller executive adds to the capabilities to interface and integrate new technology products and concepts and conduct architectural evaluations.

CREWSTATION EVALUATION FACILITY (CREST) — This facility is a flexible, modular laboratory concept used to develop, evaluate, integrate, and demonstrate advanced technology concepts in human factors engineering, display engineering, and crewsystem integration. The laboratory complex consists of: (1) Decision Aiding and Voice Experimental Lab; (2) Computer Aided Design Lab; (3) Lighting Lab; and (4) Dynamic Crewstation Simulation Lab. It is capable of supporting a wide variety of traditional engineering analyses and human factors experiments on existing or proposed display and control subsystems. Multi-function controls/displays, voice interactive systems, scene and target generation equipment, programmable symbol generators, video processing equipment, and artificial/distributed intelligence processors enable in-house evaluation of advanced aircraft concepts and technology under a realistic mission-task environment. It also provides the means to evaluate crewstation designs, operator strategies and performance, and handling qualities early in the design cycle of advanced aircraft.

TACAIR SYSTEMS DEVELOPMENT FACILITY (TSDF) — This facility will focus the specific development efforts of specialized NAVAIRDEVCEN laboratories into one comprehensive systems engineering tool. Generic in nature, the TSDF will consist of an air-to-air crewstation and an air-to-ground crewstation connected by a common computer/control laboratory. Uniquely designed as a flexible simulation as well as stimulation laboratory, the TSDF will be capable of supporting the entire TACAIR development cycle from concept formulation and evaluation to actual hardware integration on a systems level. The initial air-to-air bay configuration is designed to support F-14D R&D issues. The initial air-to-ground bay configuration will address the advanced F/A-18 C/D and night attack initiatives. Future configurations will explore, from a systems engineering approach, advanced avionics architecture, advanced controls and displays, improved flying qualities, mission planning, night vision systems and other technologies expected to be valuable in an improved Navy Advanced Tactical Fighter (ATF) and Advanced Tactical Aircraft (ATA).

HYBRID MICROELECTRONICS LABORATORY — This laboratory provides the capability of fabricating thin film, thick film and surface mount circuits and components. It contains a clean room facility for fabricating thin film hybrid circuits, as well as a screen printer, IR furnace, abrasive trimmer, and bonding and sealing equipment to fabricate thick film and surface mount circuits. In addition, a laser system, for scribing and drilling ceramic substrates is being added to improve operations. This capability is used to support various end products and 6.2 technology investigations. The laboratory provides for rapid turnaround from circuit board design to final product.

OCEANOGRAPHIC SYSTEMS PROGRAM (OSP) LABORATORY — This laboratory, containing computer equipment and accociated peripherals and various navigation equipments, provides support to the Oceanographic Survey Ships USNS BOWDITCH, USNS DUTTON, USNS HESS, and USNS WYMAN. These ships produce, accurately and at high speed, contour maps of the ocean floor as a function of the ship's position. The laboratory provides the capability of integrating new system

FACILITIES (cont.)

equipments and developing and assessing new computer algorithms for OSP systems; and supports the development of system equipments and assessment of new concepts for navigation systems.

NAVSTAR GLOBAL POSITIONING SYSTEM (GPS) LABORATORY — NAVAIRDEVCEN has been designated as the Navy's Central Engineering Activity (CEA) for systems integration and sustaining engineering for the Navstar Global Positioning System (GPS). This laboratory provides the facilities for performing design/system integration, product engineering, operational certification, and product support for all Navy users of GPS. The laboratory provides the following capabilities: user equipment test facility for checkout of host system sensor integration with GPS receiver and controller; integrated satellite signal generator facility to investigate RF spectrum and satellite constellation effects on system performance; and data processing and software simulation facility for data reduction and analysis from laboratory and field testing.

TACAMO LABORATORY — NAVAIRDEVCEN has been designated as the lead development laboratory for the new TACAMO aircraft, E-6A, as well as the avionics upgrades planned for installation once the new system is operational. This laboratory provides support for subsystem and system level development, test and evaluation necessary before installation and checkout aboard operational aircraft. It provides a complete mock-up of planned aircraft avionics configurations during each block upgrade and is divided into four major components: software development, simulation and stimulation facility for avionics control, message processing and display; communications central facility to emulate all human interfaces, radio interfaces and subsystem controls; subsystem development and integration facility; and very low frequency (VLF) radio room for RF transmitter development. The facilities are integrated to assure total system emulation.

PROGRAM WORK

The program effort is directed toward the development of naval aircraft systems, less aircraft-launched weapon systems. Within this mission the NAVAIRDEVCEN conducts a full spectrum of support of naval aviation from future model aircraft configuration requirements to fleet support in current aircraft problems. Major areas of effort include:

- Airborne ASW Systems
- Airborne Expendable Microwave Countermeasures
- Air Command and Control Systems
- Airborne Communications Systems
- Air Crew Equipment and Life Support
- Airborne Active and Passive Search, Reconnaissance, and Surveillance Systems and Equipment
- Navigation Systems, both Inertial and Autonomous, for Air, Surface and Subsurface platforms
- Naval Airborne Targets
- Naval Air Vehicles including Unmanned Air Vehicles
- Aircraft Systems
- Air Vehicle Modification and Equipment Installation

In general the programs fall into two broad categories: (1) systems programs, and (2) technology programs. Representative systems programs include:

- NAVSTAR Global Positioning System
- V/STOL Aircraft
- F-14 and PHOENIX Missile
- F/A-18 Block Upgrades
- Carrier Antisubmarine Warfare Module
- P-3C Aircraft Weapon System
- S-3 Aircraft Weapon System
- Target Systems Development
- ASW Avionics Improvements
- TACAMO
- Oceanographic Systems Program
- Joint Tactical Information Distribution System
- Warfare Systems Architecture

Representative technology programs include:

- Ring Laser Gyro Navigation System
- HALE-High Altitude Long Endurance RPV
- HARPSS-High Altitude Remote Platform Surveillance System
- Composite Structures for Aircraft
- Aircraft Materials and Corrosion Protection
- V/STOL Technology
- Advanced AEW Radar
- Aircrew Protection
- Oceanographic Technology
- Low Cost Sonobuoy
- Application of Artificial Intelligence
- Unmanned Air Vehicle Systems
- Navigation Based Gridlock
- Helmet Mounted Displays
- Enhanced Fighter Maneuverability Aircraft
- Advanced Lighter Than Air Vehicle
- Low Observable Vehicle Technology
- Advanced Magnetic Storage Technology
- Optical Computing and Networking

PROGRAM WORK (cont.)

Non-Destructive Evaluation of Metal, Ceramic and Matrix Composites

Target Systems Development

Airborne Common Acoustic Processing

Enhanced Modular Signal Processor Development

NAVAIR Software Engineering Environment

Advanced Technology Cockpit

Decision Aiding Research

Computational Fluid Dynamics

Navy Aircrew Common Ejection Seat

Aircraft Fuel Conservation RDT&E Program

The NAVAIRDEVCEN has definitive control over the following technology base block programs:

Airborne Surveillance

Air ASW Surveillance

Air Vehicles

Airborne Electronic Warfare

Airborne Materials

Navigation and Aircraft Command, Control and Communication

MAJOR ACCOMPLISHMENTS (FY-1987)

ACOUSTIC/NON-ACOUSTIC SENSORS — Developed new family of low cost, short range, air droppable passive acoustic sensors to increase the operational and cost effectiveness.

CARRIER ANTISUBMARINE WARFARE MODULE — Completed installation of Model 4.0 and delivered initial Model 4.1 software.

P-3C UPDATE IV — Completed demonstration/validation phase of avionics program.

UNMANNED AUTONOMOUS VEHICLES (UAV'S) — Conducted Pioneer mishap investigations, assessed risks, and recommended reduction approaches.

GLOBAL POSITIONING SYSTEM (GPS) — Delivered initial production GPS sets for integration on SH-60B and A6-F for TECHEVAL and OPEVAL.

NAVAIR SOFTWARE ENGINEERING ENVIRONMENT (SEE) — Defined common tool set for major life cycle needs and initiated procurement for same.

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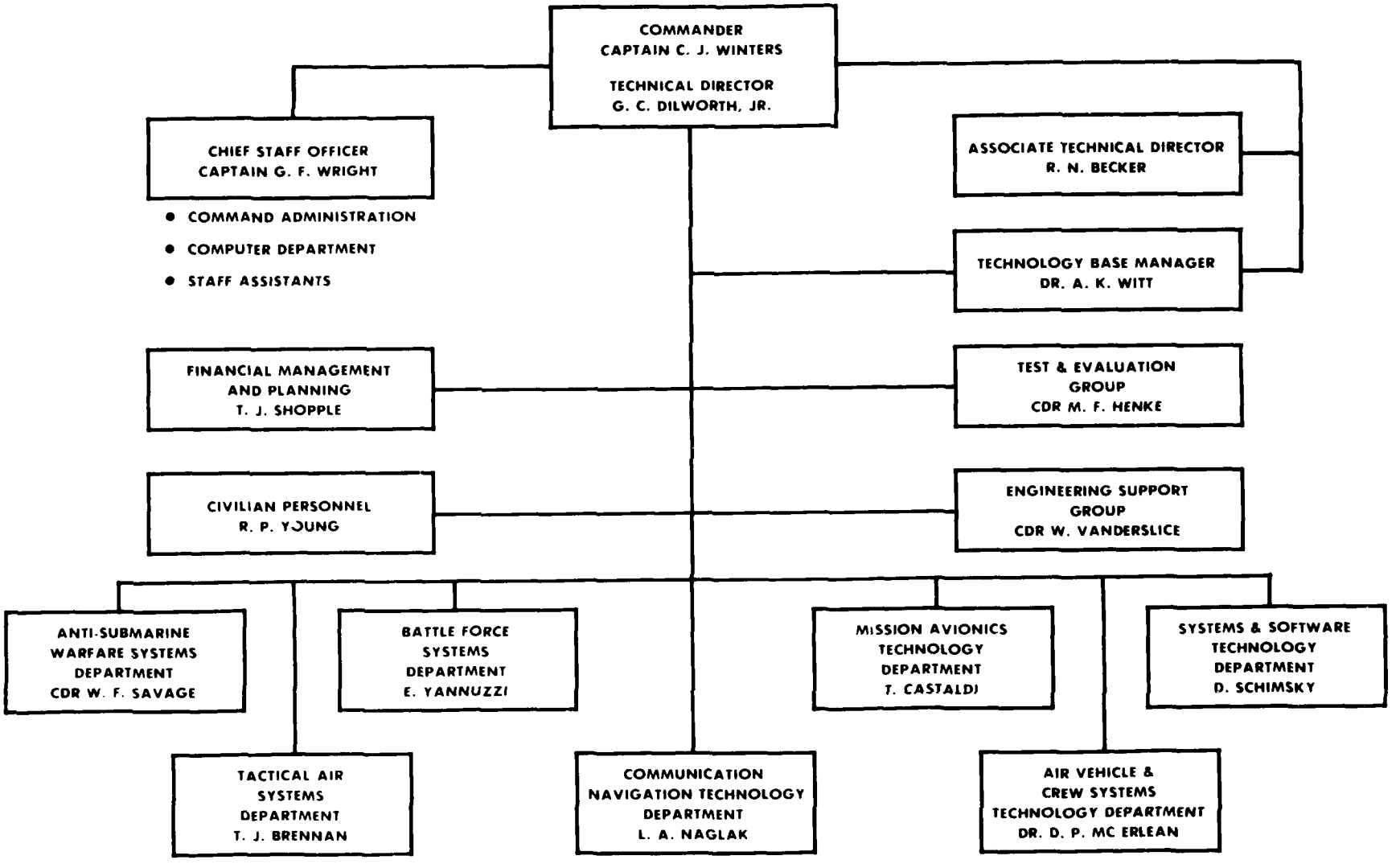
COMPOSITE STRUCTURES — Two bismaleimide (BMI) resin prepregs have been successfully processed into void-free composite laminates using a unique non-autoclave/staging process. The immediate application of this process is the manufacture of prefabricated field and depot level battle damage repair patches which can be stored and applied at ambient temperatures.

REMOTELY PILOTED VEHICLES (RPV) — Developed and demonstrated a Real Time Reconnaissance System (RTRS) for use in expendable RPV applications.

F-14 FLAT SPIN — Used the Dynamic Flight Simulator (DFS) to familiarize fleet pilots with F-14 spin onset and departure/recovery methods. Determined that pilots are capable of recovering an F-14A aircraft under the negative G environment of a flat spin.

LOW OBSERVABLES — Institutionalized efforts in stealth and counterstealth technology to include improvements in Infrared Search and Track (IRST) and lightweight radar technology.

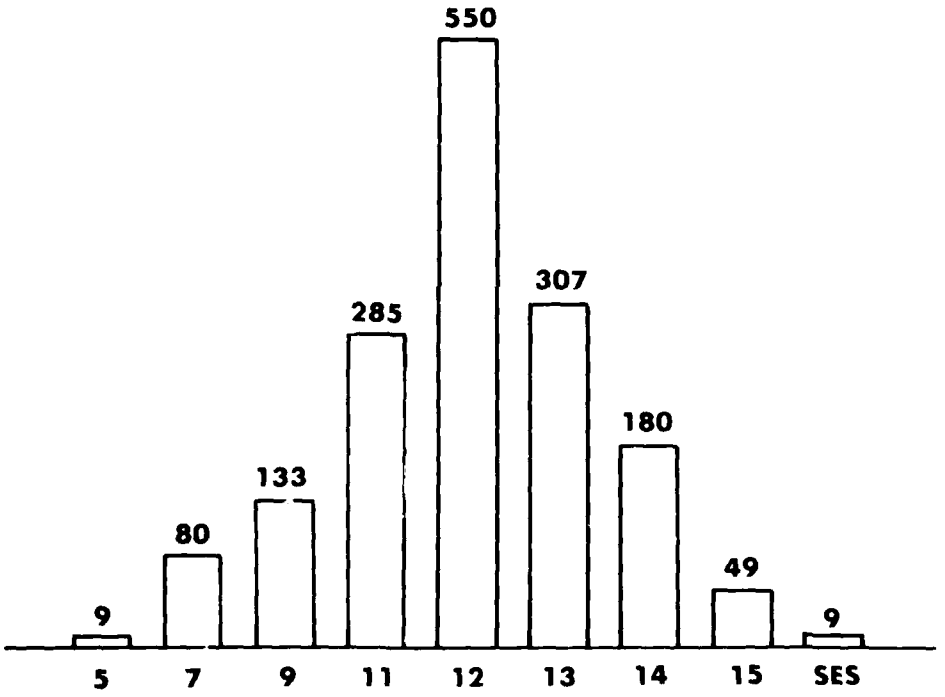
NAVAL AIR DEVELOPMENT CENTER



30 SEPTEMBER 1987

PERSONNEL DATA

ON BOARD	MILITARY	CIVILIAN	FTP	PTP	OTHER*	TOTAL PERMS	FTP UNGRADED	FTP GRADED
	234	2772	2668	27	77	2695	197	2471



SCIENTISTS & ENGINEERS BY GRADE

ADMINISTRATIVE	236
TECHNICIANS - S&E	151
OTHER	482
SCIENTISTS & ENGINEERS	1602
ELECTRONIC ENGR.	887
AEROSPACE ENGR.	185
GENERAL ENGR.	111
MECHANICAL ENGR.	114
OPERATIONAL RESEARCH ANALYST	72
COMPUTER SCIENTIST	115
PHYSICIST	28
MATHEMATICIAN	9
MATERIALS ENGR.	35
CHEMIST	9
ELECTRICAL ENGR.	9
OTHER	28
TOTAL	2471

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MILITARY BILLETS AUTHORIZED

OFFICER	ENLISTED
56	194

*INCLUDES TEMPORARY, INTERMITTENT (SUMMER EMPLOYEES EXCLUDED)

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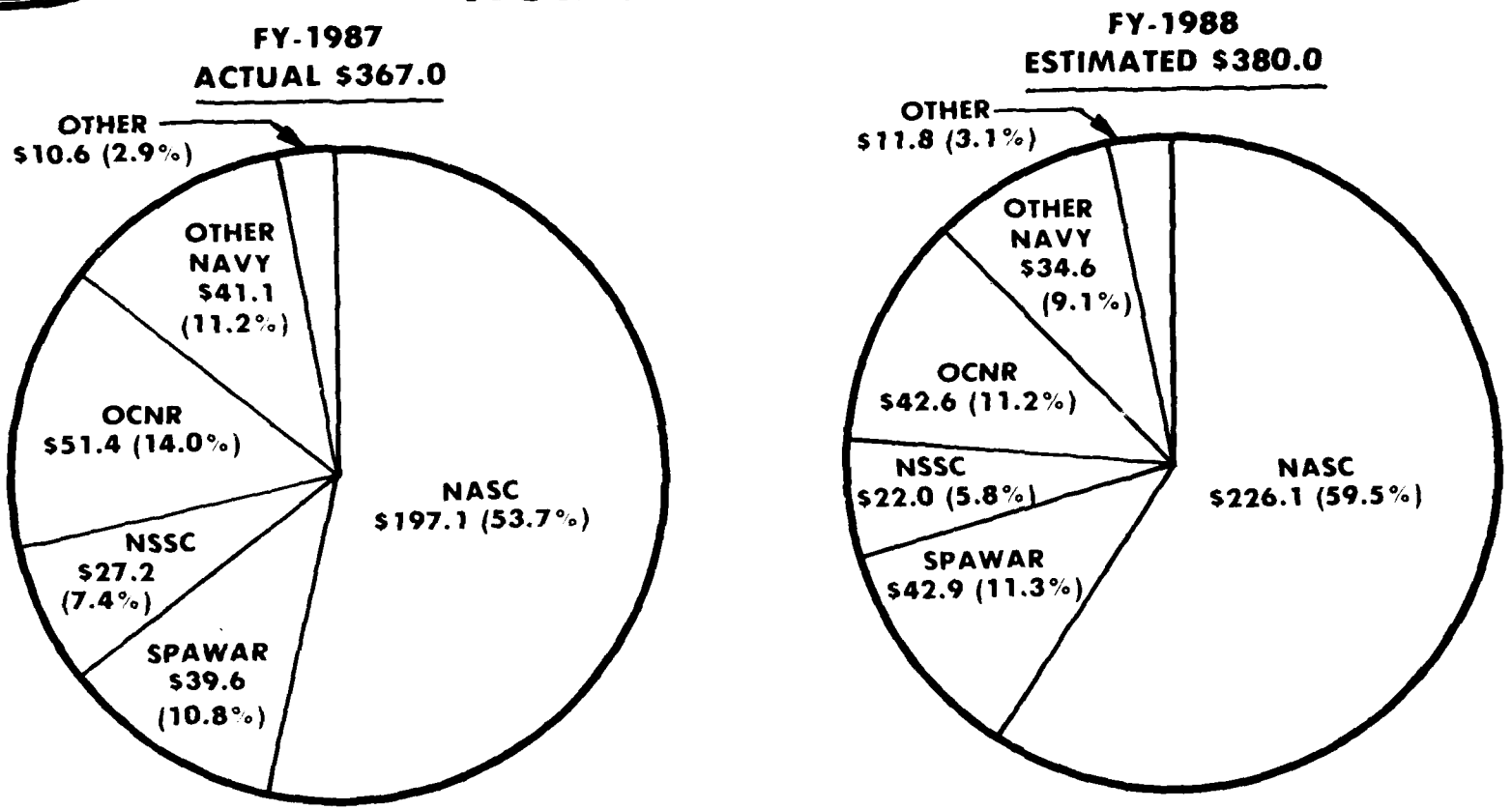
SOURCE OF FUNDS
NOR $ IN MILLIONS

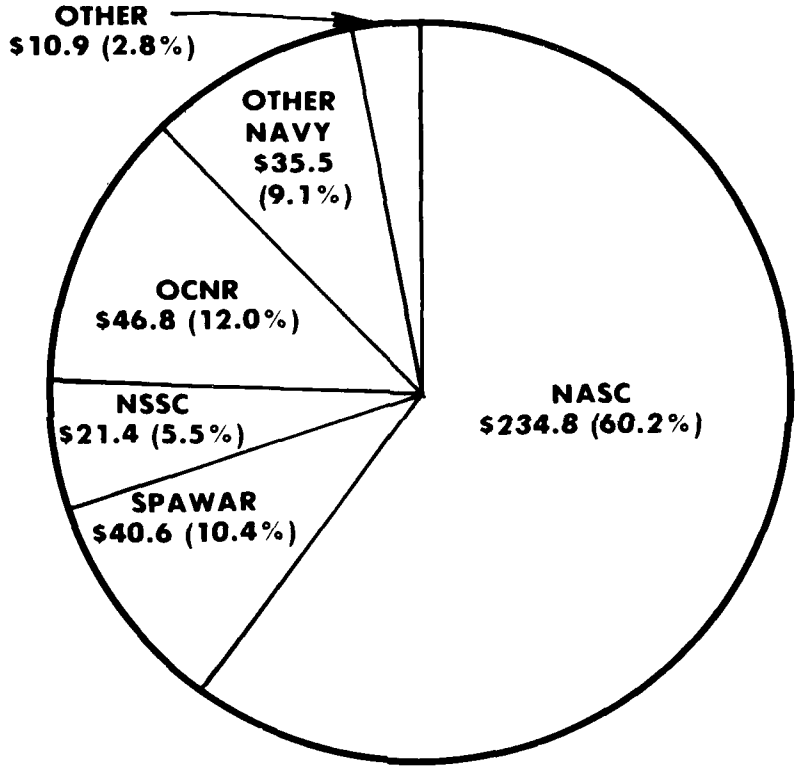


OCNR - CHIEF OF NAVAL RESEARCH
NASC - NAVAL AIR SYSTEMS COMMAND
NSSC - NAVAL SEA SYSTEMS COMMAND
SPAWAR - SPACE AND NAVAL WARFARE SYSTEMS COMMAND

30 SEPTEMBER 1987

SOURCE OF FUNDS
NOR $ IN MILLIONS

FY-1989
ESTIMATED $390.0



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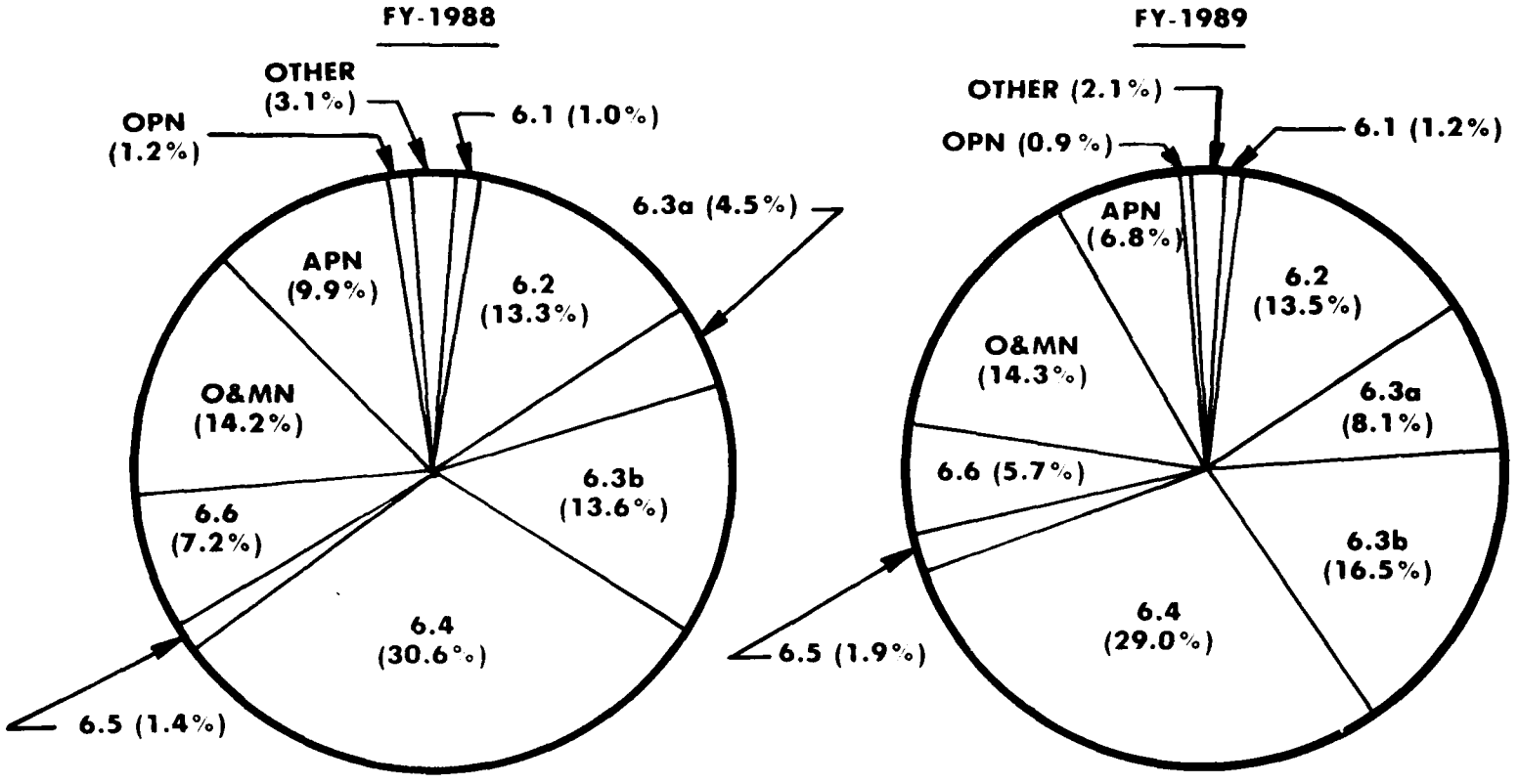
FUNDING BY APPROPRIATION

NOR $ IN MILLIONS



30 SEPTEMBER 1987

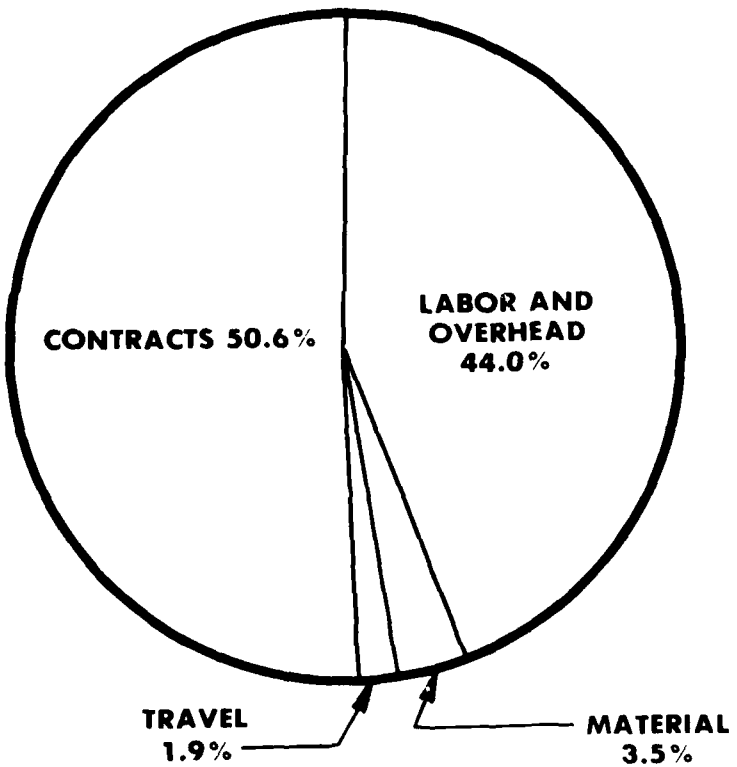
FUNDS BY CATEGORY AND TYPE

NOR $ IN MILLIONS

CATEGORIES & TYPE	FY-1987			FY-1988			FY-1989		
	$M	% OF TOTAL		$M	% OF TOTAL		$M	% OF TOTAL	
	ACT.	RDT&E	TOTAL	EST.	RDT&E	TOTAL	EST.	RDT&E	TOTAL
RDT&E (CATEGORY)									
6.1 RESEARCH	5.1	2.2	1.4	3.8	1.4	1.0	4.7	1.6	1.2
6.2 EXPLORATORY DEVELOPMENT	46.6	19.6	12.7	50.5	18.6	13.3	52.7	17.8	13.5
6.3a ADVANCED TECHNOLOGY DEVELOPMENT	9.9	4.2	2.7	17.1	6.3	4.5	31.6	10.7	8.1
SUBTOTAL	61.6	26.0	16.8	71.4	26.3	18.8	89.0	30.1	22.8
6.3b ADVANCED DEVELOPMENT	33.0	13.9	9.0	51.7	19.0	13.6	64.3	21.7	16.5
6.4 ENGINEERING DEVELOPMENT	107.5	45.4	29.3	116.3	42.7	30.6	113.1	38.2	29.0
6.5 MANAGEMENT & SUPPORT	11.4	4.8	3.1	5.3	1.9	1.4	7.4	2.5	1.9
6.6 OPERATIONAL SYSTEMS DEVELOPMENT	23.5	9.9	6.4	27.4	10.1	7.2	22.2	7.5	5.7
SUBTOTAL	175.4	74.0	47.8	200.7	73.7	52.8	207.0	69.9	53.1
TOTAL RDT&E	237.0	100.0	64.6	272.1	100.0	71.6	296.0	100.0	75.9
(O&MN) OPER. & MAINT., NAVY	47.0		12.8	53.9		14.2	55.8		14.3
(APN) AIRCRAFT PROCUREMENT, NAVY	39.3		10.7	37.6		9.9	26.5		6.8
(OPN) OTHER PROCUREMENT, NAVY	16.9		4.6	4.6		1.2	3.5		0.9
OTHER	26.8		7.3	11.8		3.1	8.2		2.1
OTHER APPROPRIATION SUBTOTAL	130.0		35.4	107.9		28.4	94.0		24.1
TOTALS	367.0		100.0	380.0		100.0	390.0		100.0

30 SEPTEMBER 1987

DISTRIBUTION OF FUNDS
NOR $ IN MILLIONS



	FY-1988	FY-1989
LABOR & OVERHEAD	167.2	171.6
MATERIAL	13.2	13.7
TRAVEL	7.1	7.4
CONTRACTS	192.5	197.3
TOTAL	380.0	390.0

30 SEPTEMBER 1987

LEADERSHIP ASSIGNMENTS

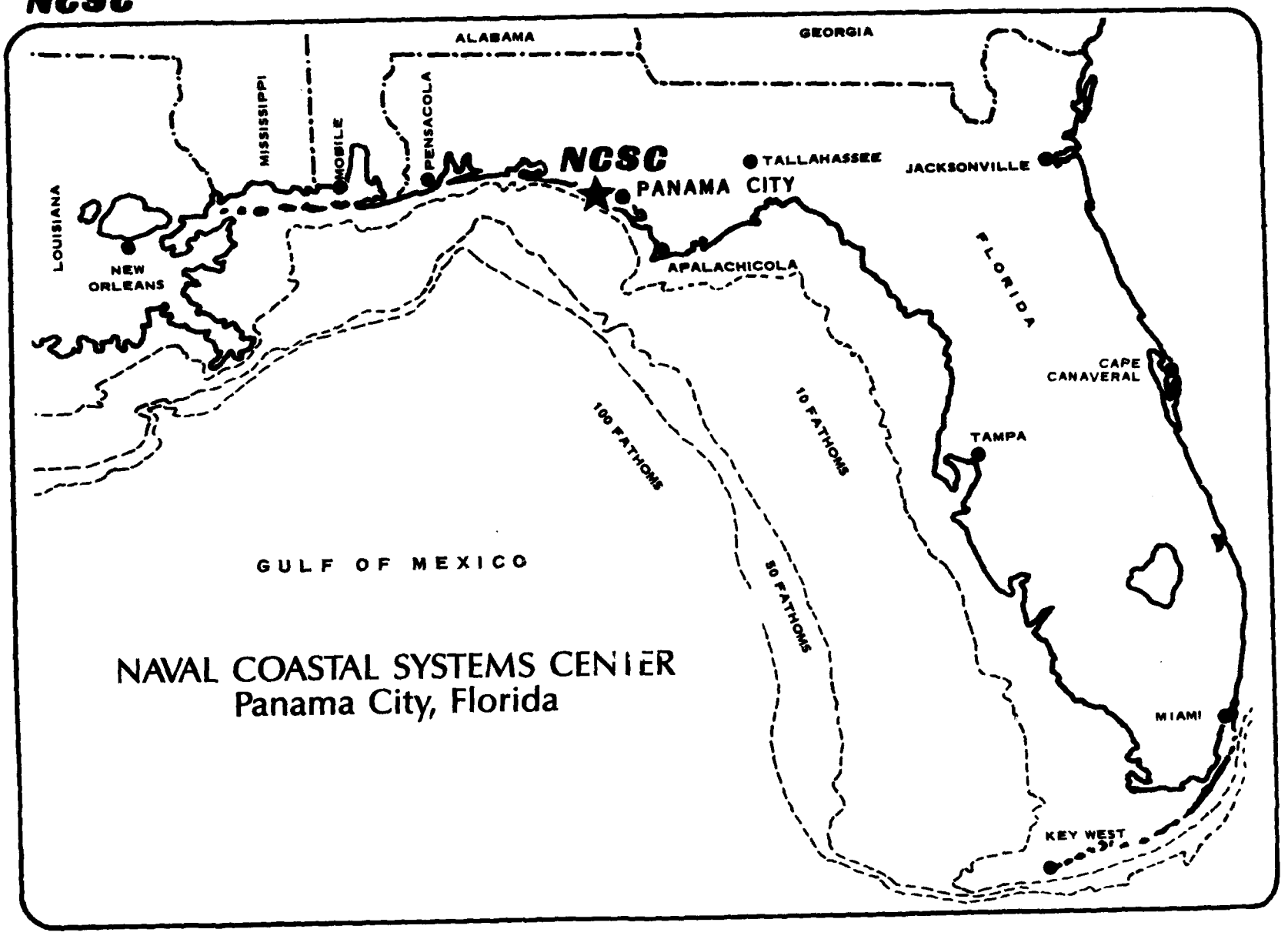
NAVAIRDEVCEN is responsible for Navy-wide leadership in:

a. Air warfare analysis with NAVWPNCEN (AAW, ASUW, STRIKE)
b. Air ASW warfare analysis
c. Air combat systems engineering and integration with NAVWPNCEN
d. Air vehicles
e. Air vehicle-related human factors
f. Aircraft, surface ship, and submarine navigation systems
g. Aircraft crew equipment life support
h. Air command and control systems
i. Aerial targets (sub-scale)

NAVAL COASTAL SYSTEMS CENTER BRIEF

APPROVED FOR PUBLIC RELEASE

NCSC



30 SEPTEMBER 1987

NCSC

MISSION

THE MISSION OF THE NAVAL COASTAL SYSTEMS CENTER IS TO BE THE PRINCIPAL NAVY RDT&E CENTER FOR MINE AND UNDERSEA COUNTERMEASURES, SPECIAL WARFARE, AMPHIBIOUS WARFARE, DIVING, AND OTHER NAVAL MISSIONS THAT TAKE PLACE PRIMARILY IN THE COASTAL REGIONS.

Ref: NAVMATINST 5450.27C

HISTORY

The nucleus of the Naval Coastal Systems Center was derived from mine countermeasures research conducted during World War II at the U. S. Navy Mine Warfare Test Station, Solomons Island, Maryland. In 1945, equipment, facilities, and personnel were transferred from Solomons Island to Panama City on a 373-acre site formerly occupied by a wartime Naval section base. The new facility was commissioned on 1 September 1945 as the U. S. Navy Mine Countermeasures Station. Ten years later, on 1 July 1955, the Station was redesignated the U.S. Navy Mine Defense Laboratory (MDL). Later the physical site was enlarged to over 600 acres and the mission expanded to include airborne mine countermeasures, torpedo countermeasures, in-shore warfare, swimmer / diver support, and amphibious warfare. On 1 November 1967 the Laboratory became an activity of the Naval Ship Research and Development Center, Carderock, Maryland, and on 7 November 1968 was renamed the Naval Ship Research and Development Laboratory, Panama City. Redesignation as the Naval Coastal Systems Laboratory occurred on 1 February 1972 and on 1 March 1978 it was redesignated the Naval Coastal Systems Center (NAVCOASTSYSCEN). Major tenant organizations at NAVCOASTSYSCEN are the Navy Experimental Diving Unit, Assault Craft Unit 4, and the Naval Diving and Salvage Training Center. NAVCOASTSYSCEN's size and responsibilities have expanded steadily over the past four decades to meet the Navy's changing requirements. Throughout this period, NAVCOASTSYSCEN has distinguished itself in technical achievement and in the fulfillment of its mission.

INTRODUCTION

The Naval Coastal Systems Center (NAVCOASTSYSCEN), in fulfillment of its mission to be the "principal Navy RDT&E Center for mine and undersea countermeasures, special warfare, amphibious warfare, diving and salvage, and other Naval missions that take place primarily in coastal regions," has been providing new techniques and enhancing old concepts in support of operating forces since 1945. Included in this mission has been the development and evaluation of systems and equipment in response to critical military problems encountered in coastal regions along with providing on-scene technical expertise to operational forces.

As a major research and development activity of the Space and Naval Warfare Systems Command, NAVCOASTSYSCEN has developed or significantly influenced virtually every type of mine, torpedo, and sonar countermeasure system in operational use today. The Center has become the Navy's principal activity in the development of undersea weapon countermeasure systems

As a result of the Center's involvement in diving and salvage R&D over the years, significant accomplishments have been achieved in the areas of undersea habitats, submersibles, navigation, communication, tools, and life support systems for Navy combat and working swimmer-divers. Panama City has become the Navy's center for technology and expertise in diving and salvage with the augmentation of NAVCOASTSYSCEN's program by the Navy Experimental Diving Unit and the Naval Diving and Salvage Training Center, tenant commands.

Substantial contributions have been made by NAVCOASTSYSCEN in the development of techniques and equipment for use by amphibious and coastal/special warfare forces. The Center has developed systems for coastal surveillance, coastal and harbor defense, swimmer defense, and barrier sensor. In addition, the Center has been involved in activities such as amphibious logistics support, ship development and amphibious assault craft testing, remote environmental sensing, and surf zone and Marine Corps land mine countermeasures.

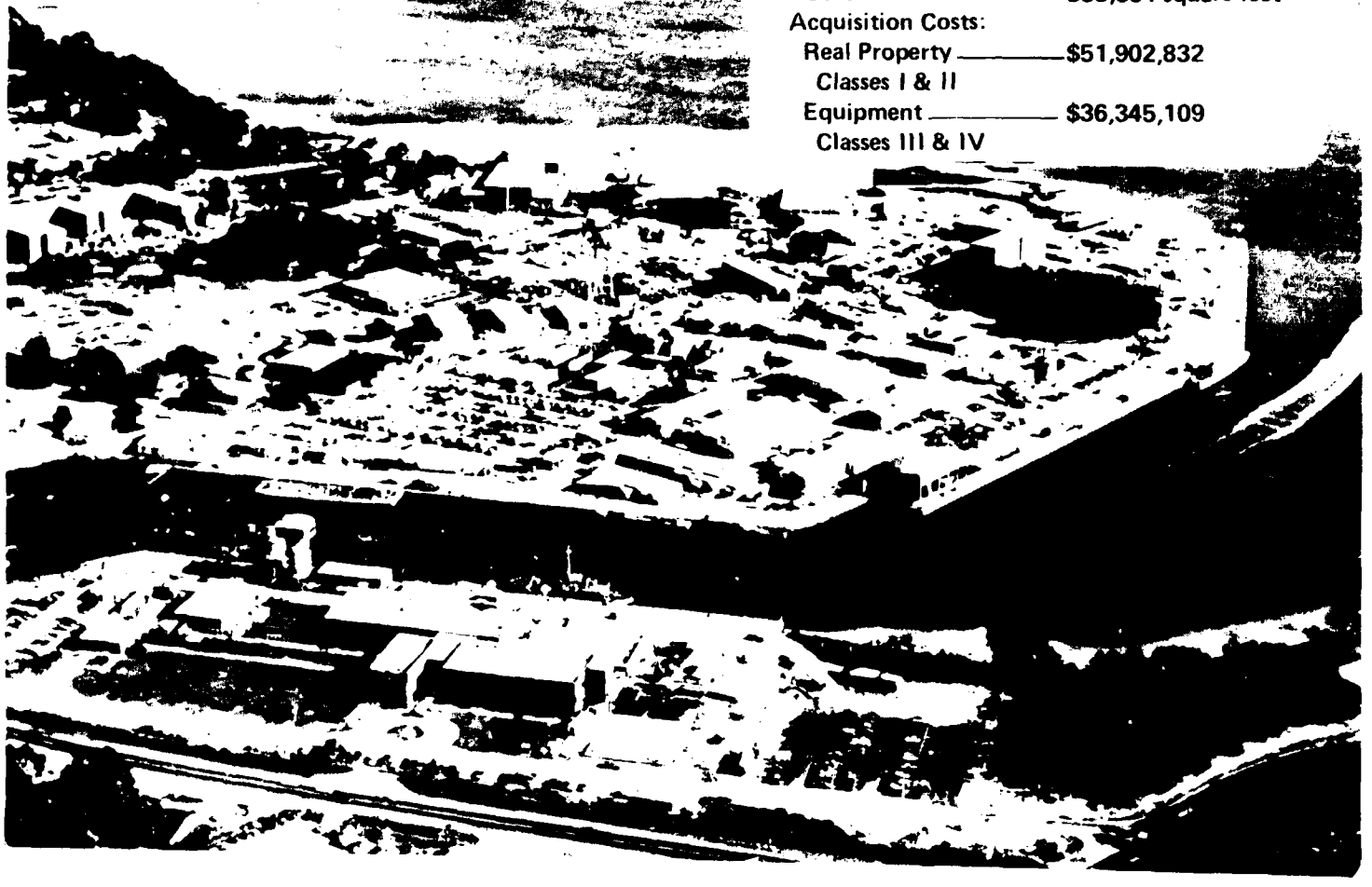
Through investigations and the develoment of basic technologies that support the Center's mission, specialized sciences and capabilities have been developed. These include solid and liquid acoustic lens technology and digital signal processing techniques for use with high definition sonars; simulation of equipment/systems operations in shallow seas for research in undersea weapons and sensor countermeasures; magnetics and cryogenics technology for object detection, signature classification, and sensor design; hydrodynamics modeling for the design and evaluation of towed surface and subsurface vehicles; coastal sonar technology and acoustic resonant signal physics for threat detection, classification and localization, based on computer-aided methodology; electro-optic scanners for hydrographic surveys and bathymetry; and wake generation research and modeling.

NAVCOASTSYSCEN has been designated the lead Center or Technical Direction Agent (TDA) for US Marine Corps Tactical Deception Program, Naval Special Warfare Program, Submarine Sonar, Torpedo and Mine Countermeasures, Amphibious Warfare and Strategic Sealift, Diving and Salvage, Shipboard Lighting, Advanced Minehunting Sonar System (AMSS), Catapult Launched Fuel Air Explosive (CATFAE) land mine warfare system, Airborne Minehunting Reconnaissance System (AMRS), Precise Integrated Navigation System (PINS), Navy One Man Atmosphere Diving System (NOMADS), and the MCM-1 Ship Combat Systems Integration Program. In addition, the Center is the test, trials, and post delivery manager for the Landing Craft Air Cushion (LCAC) vehicle program.

INTRODUCTION (Continued)

During the past fiscal year, the Naval Sea Systems Command provided 56 percent of total funding and it is projected that it will continue to be the Center's major sponsor. The out-of-house effort in FY 1987 was 39 percent. The Center employs over 1,200 civilian and 133 military personnel in accomplishing its mission. The tenant activities aboard the Center employ more than 700 military and civilian personnel.

NCSC



Land Owned/Leased ——— 648 acres

Buildings:

Laboratory	358,636 square feet
Administrative	42,503 square feet
Other	553,861 square feet

Acquisition Costs:

Real Property Classes I & II	$51,902,832
Equipment Classes III & IV	$36,345,109

FACILITIES

The Naval Coastal Systems Center is located in Northwest Florida across St. Andrew Bay from Panama City, about mid-way between Pensacola and the capital city of Tallahassee. This 648-acre site stretches almost 2 miles along St. Andrew Bay and has a deep, protected harbor with easy access to the Gulf of Mexico. One of the more important considerations in the location of NAVCOASTSYSCEN is the local natural environment with easy access to rivers, bays, and coastal waters ideally suited to the RDT&E activities of its mission areas.

COUNTERMEASURES EVALUATOR (CME)

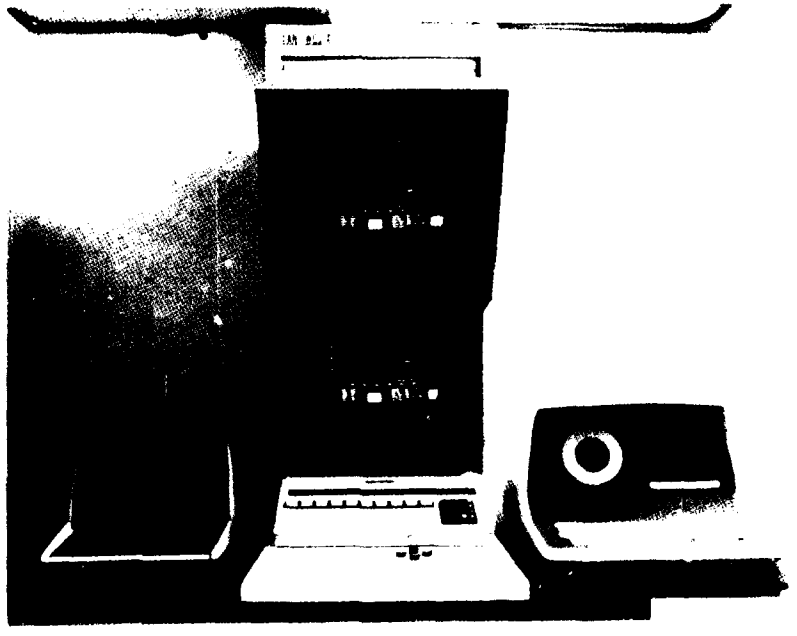
The CME is a large simulation complex originally designed for the evaluation of torpedo countermeasures systems through real-time simulation studies. The CME has been expanded to accommodate simulation of mines and platform sonars. The CME is also used in detailed real-time simulation of the dynamics of underwater bodies such as swimmer/diver vehicles and submarines. It employs operationally realistic mixes of torpedoes, ships, mines, submarines, acoustic countermeasures devices, and target decoys. In the simulation each object is modeled to react as it would in an actual encounter at sea. Actual weapon hardware is used in the simulator and is stimulated in real-time by a synthesizer controlled by 11 parallel processing computers which provide the acoustic modeling.

HYDROSPACE LABORATORY (HSL)

The Hydrospace Laboratory is a hyperbaric testing facility which enables NAVCOASTSYSCEN personnel to perform engineering evaluations of swimmer/diver equipment, deep sea and saturation diving subsystems, and related life support equipment. The HSL houses four hyperbaric chambers and two separate computer data acquisition systems which are capable of unmanned testing to simulated ocean depths of 3,375 feet. This unique facility has the hardware, software, and staff capable of performing hyperbaric equipment tests, quality assurance tests, gas and liquid flow studies, heat transfer studies, simulated manned testing, hyperbaric environmental simulation, with real time data acquisition and reduction.

ACTIVE SONAR MODEL (ASM)

The ASM is an active sonar simulation tool developed for the design and analysis of sonar countermeasure devices and tactics. It is a real-time simulation complex that permits operator interaction at the sonar watch level and at the ship's CONN level. The ASM is a dual channel simulation of a sophisticated generic active sonar system wherein each channel drives an independent active sonar display station. The platform dynamics, acoustics, receiver processing, and display markings are computed and updated digitally in real-time. Under computer control each display station can present information to its operator both aurally and visually. The ASM has been expanded to provide a passive sonar simulation capability as well.



FACILITIES (Continued)

MAGNETIC TARGET DETECTION AND CLASSIFICATION RANGE

The Magnetic Target Detection and Classification Range is comprised of work site, test tracts, and work ramps. It occupies approximately 40 acres of magnetically clean land within a 220-acre tract of limited habitability. The facility is suitable for development and tests of high sensitivity magnetometers, for mapping the magnetic fields around objects, and for the analysis of motional noise in superconducting magnetic gradiometers. The facility is equipped with cryogenic material storage and handling devices, a high-precision assembly shop and a computer system for on-line data collection and processing.

SONAR PROCESSING FACILITIES

A sophisticated data collection and analysis capability exists at NAVCOASTSYSCEN. The control component of this capability is a mini-computer and associated peripherals. A modern signal and image processing facility based on a VAX 11/780, dual Gould DeAnza image processors, a CSPI high precision Array Processor,and supporting peripherals and software, are being utilized for advanced application in Computer Aided Detection and Computer Aided Classification of military targets.

An acoustic test tank and a precision data collection system are also available for performing acoustic experiments under extremely precise conditions. Position accuracies of 0.001" in both the X-Y horizontal and vertical directions, together with 0.1° rotational accuracies are possible. The data collection system is controlled by a microcomputer. Software has been developed which permits a coherent combination of signals from different bandwidths or positions, as in the case of synthetic aperture.

ACOUSTIC TEST FACILITY (ATF)

The Acoustic Test Facility provides performance data for underwater transducers and systems. The ATF measures projector and hydrophone beam patterns, project source levels, hydrophone sensitivities, transducer impedances, and sonar system level tests. Additionally, target strength measurements may be made on various targets. The ATF consists of a fresh-water pond, a pontoon barge, and a measurement pier extending over the pond. An electronic digital system is built around an HP 9836 computer for conducting both system and subsystem (or transducer) measurements.

TRANSDUCER DEVELOPMENT LABORATORY (TDL)

The Transducer Development Laboratory provides the means to design and fabricate special purpose, one-of-a-kind, underwater electroacoustic transducers. The TDL consists of a specially constructed building with an air conditioning and ventilation system designed to remove pollutants quickly. Special equipment includes a milling machine, a pressure/vacuum insertion system, a temperature-controlled oven, an hydraulic press, an acoustic materials testing laboratory, and an instrument to measure sound velocity versus temperature. It also includes a special chemical storage room that is fireproof, vented, and has a built-in spill containment system. In addition, it has special electronic instrumentation for conducting prototype electrical measurements.

MATERIALS LABORATORY

The Materials Laboratory is responsible for the research and development of new materials which contribute to sensor enhancement. The material areas of particular interest are high temperature superconductors, graphite intercalation compounds, liquid crystals, and corrosion resistant materials. Special equipment includes scanning and transmission electron microscopes, a sputtering system, and thermogravimetric and thermal processing equipment.

GAS ANALYSIS LABORATORY (GAL)

The Gas Analysis Laboratory is a state-of-the-art chemistry laboratory dedicated primarily to the support of diving and life support systems development. The GAL employs a variety of analytical equipment including gas chromatographs, mass spectrometer, nondispersive infrared spectrometer, total hydrocarbon analyzers, paramagnetic oxygen analyzers, and total halogen detectors. This equipment, combined with the extensive experience of lab personnel, allows the GAL to provide the rapid response often required in diving and life support. Capabilities provided by the GAL include gas analysis, off-gassing analysis of polymeric materials, carbon dioxide absorption studies, precision gas mixing, helium leak detection, microscopic analysis, microphotography, toxic gas analysis, calibration of analysis equipment, evaluation of gas analysis sensor, moisture analysis of gases and solids, oil analysis, compatibility testing, and other chemical-related tasks.

CENTER TEST RANGES

The Center Test Ranges provide the environments and instrumentation required for testing a wide spectrum of naval equipment. The Range is currently undergoing a multiyear improvement program to include testing of line charge devices and air cushion vehicles; seven additional test areas with varying environments, depths, and distance from shore line will be provided. Tracking will be available in all of the areas.

The Gulf Test Range, currently in operation, is adjacent to the shore on the Gulf of Mexico and includes four beach operating sites. Located offshore is an Influence Range consisting of magnetic, pressure, and acoustic sensors, and instrumented targets. Services available include tracking, craft signature measurements, and mine reaction measurements. The range also contains a data acquisition system designed to acquire, process, and store data from the Influence Range, tracking systems, and an environmental monitoring system. The environmental monitoring system provides both oceanographic and atmospheric data on the Gulf Test Range. Full communications support, including telephone, radio, and datalink, is available.

SOFTWARE ENGINEERING ENVIRONMENT FOR TACTICAL EMBEDDED COMPUTERS (SEETEC)

The SEETEC facility provides the total engineering support for development of mission critical computer software. SEETEC employs VAX-11/780, VAX-11/785, VAX-8200, Gould 9780 and Gould 6781 computers and peripheral support equipment. The AN/UYK-44 standard militarized minicomputer and various commercial microprocessors are also interfaced to the VAX computers. Access to SEETEC is provided via 50 plus terminals and engineering work stations located in the engineers' workspaces.

The tools provided by the integrated SEETEC procedures and methods allow any particular phase of software life cycle to rely on historical data while building future data bases. This phased modular approach improves the productivity of the personnel involved in the development process and the quality and maintainability of future NAVCOASTSYSCEN software products.

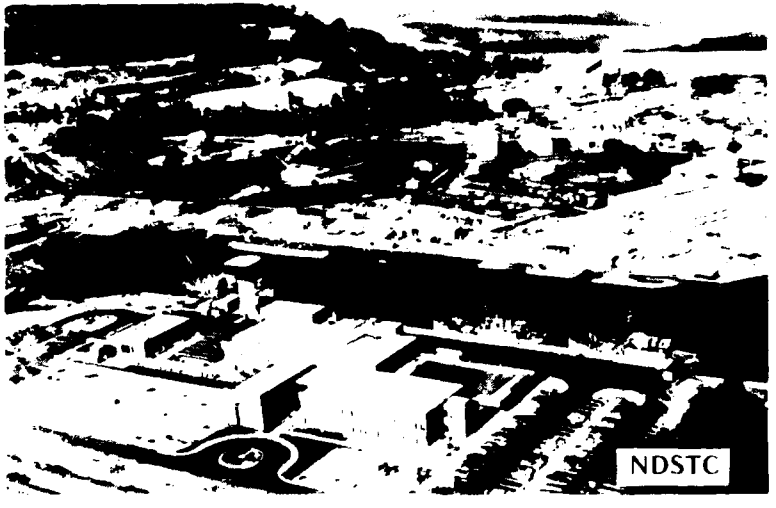
FACILITIES (Continued)

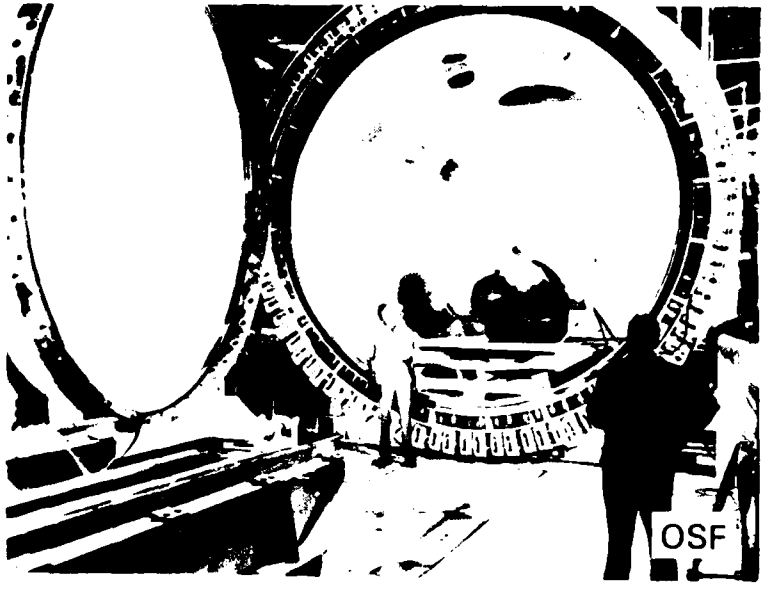
NAVAL DIVING AND SALVAGE TRAINING CENTER (NDSTC) - TENANT OPERATED

The Naval Diving and Salvage Training Center trains nearly one thousand divers annually in all modes of diving. Divers graduating from the dive school perform in ship repair, salvage and rescue, and construction and demolitions billets throughout the world. The Center also trains divers employed by all other branches of the armed services, some other government agencies, and some foreign militaries. The dive school was relocated to NAVCOASTSYSCEN from Naval Station Washington, D. C. in 1980. The school has extensive facilities, which include:

- three pressure vessel assemblies for closely-controlled deep dive familiarization training
- two small craft equipped for open sea diving
- a fifty-foot free ascent tower for scuba survival training
- a 30 meter heated training pool
- numerous classrooms and support buildings

Two major milcons are currently in progress which will double the classroom and office space of the Center by 1989.





OCEAN SIMULATION FACILITY (OSF) - TENANT OPERATED

The OSF is a unique hyperbaric research facility for development, test, and certification of manned diving and working systems. It is man rated for safe operation to 1000 psig or ocean depth of 2250 feet. The facility permits testing in controlled ocean conditions including desired temperatures, light level, turbidity and pressure. Swimmer propulsion devices, small submersibles, and diving innovations can be tested in near-actual conditions in the safety of a controlled laboratory environment where medical and engineering monitoring of men and equipment is possible. The facility supports Naval programs in diving and ocean engineering and serves other government agencies, industry, and educational institutions. The facility is maintained and operated under the command of the Navy Experimental Diving Unit.

OTHER MAJOR FACILITIES

Other major facilities supporting the Center's mission are a heliport for airborne tasks, over 2800 linear feet of pier space, and a LCAC ramp for testing and training LCAC vehicles and crews.

PROGRAM WORK

AIRBORNE MINE COUNTERMEASURES
- Advanced Minehunting/Reconnaissance System (AN/ALQ-20)
- AMCM Magnetic Mine Sweeping System (AN/ALQ-166)
- Minesweeping Set (A/N37U-1)
- Airborne Mine Neutralization System
- Bottom Classification
- Sweep Array Concepts
- Naval Operations and Maintenance Aviation Deck (NOMAD)
- Air MCM Fleet Readiness

SURFACE SHIP MINE COUNTERMEASURES
- MCM Ship Combat Systems Engineering & Integration
- Minehunting Sonar (AN/SQQ-30)
- Mine Warfare Simulator
- Integrated Shipboard System
- Craft of Opportunity (COOP)
- MSO Product Improvements
- In-Service SMCM Precise Navigation
- Precise Integrated Navigation System (PINS) (AN/SSN-2)
- Influence Minesweeping System (AN/SLQ-37)
- MHC Ship Combat Systems Engineering & Integration
- Advanced Minehunting Sonar System (AN/SQQ-32)
- Mine Neutralization System (AN/SLQ-48)
- Tactical Displays
- Global Positioning System (GPS)
- Minesweeping System Acoustic (MSSA MK 1) (OSBORN)
- Rapid Shallow Water Mine Countermeasures
- Versatile Exercise Mine System (VEMS)
- Magnetic/Acoustic Detection of Mines (MADOM)
- Neutralization Sensor Technology
- Multi-Aspect Sonars
- Controlled Depth Mechanical Sweep
- Remotely Controlled Minehunting System
- Acoustic Classification Technology

SONAR AND TORPEDO COUNTERMEASURES
- Passive Torpedo Detection System Improvements (AN/BLR-14)
- Countermeasure Launcher Systems (CSA MK 2)
- Advanced Torpedo Decoy (ADC MK 3)
- Advanced Sonar Countermeasures (ADC MK4)
- SSN-21 C/M Launchers
- Advanced Torpedo Defense for Surface Ships and Submarines
- Sonar and Torpedo Countermeasures Simulation Technology

AMPHIBIOUS WARFARE SUPPORT
- Amphibious Warfare Analysis
- Merchant Ship Naval Augmentation Program (MSNAP)
- Amphibious Ship Systems Integration (LSD/LHD/LCAC)
- Strategic Sealift Systems Integration
- LHD-1 Acquisition Support
- LC-X Development Program
- Logistics Over-the-Shore Analysis

MARINE CORPS TACTICAL DECEPTION
- Tactical Deception Technology
- Tactical Decoy Measurement Program
- Marine Corps Basic TACD Capability (Quick-Fix)

MARINE CORPS LAND MINE WARFARE
- Airborne Detection & Survey Optics Technology
- Land Mine Countermeasures (LMC)
- Catapult Launched Fuel Air Explosive Program (CATFAE)
- M58/M68 Product Improvement
- Anti Personnel Obstacle Breaching System (APOBS)
- Cleared Lane Marking System (CLAMS)
- Military Amphibious Reconnaissance System (MARS)
- Combat Engineer Tractor (CET)
- Sensor and Neutralization Technology for LMC

PROGRAM WORK (CONTINUED)

COASTAL/SPECIAL WARFARE SUPPORT
- Swimmer Delivery Vehicles (SDVs)
- Naval Special Warfare Mobility Improvement Program
- MK VIII Upgrade Product Improvement
- Naval Special Warfare R&D Master Plan
- Advanced SEAL Delivery System
- Swimmer Area Navigation System (SANS)
- Underwater Acoustic Equipments
- Waterside Security System (WSS)
- Advanced Underwater Breathing Apparatus
- Active Diver Thermal Protection System

OCEAN ENGINEERING AND MECHANICAL ENGINEERING
- Conventional Diving System
- UBA MK 14 MOD 1
- Lightweight Diving System
- Sampling and Analysis of Navy Divers' Breathing Air
- Diver Thermal Protection
- Navy One Man Atmosphere Diving System (NOMADS)
- Fire Fighters Breathing Apparatus (FFBA)
- Submarine Hull Weld Inspection
- Underwater Ship Hull Inspection Techniques

WARFARE ANALYSIS
- Warfare Analysis for Center Mission Areas
- Mission Analysis
- Threat Analyses and Requirements
- Sonar & Torpedo Countermeasures Simulation and Analysis
- Program Cost Analysis
- Tactical Development and Evaluation
- Foreign Material Exploitation Program
- Foreign Weapons Evaluation Program
- Engineering Specialty Integration
- Exercise Analysis and Evaluation
- Systems Concept Trade Off Analysis
- Systems Effectiveness Analysis
- Analysis Model Development
- Naval Science Assistance Program Coordination

ADVANCED ENGINEERING & TECHNOLOGY DISCIPLINES
- Very High Speed Integrated Circuits (VHSIC)
- Autonomous Vehicle Navigation, Guidance, and Control for Large Scale Vehicle (LSV)
- Integrated Navigation Analysis
- Artificial Intelligence for Underwater Vehicles
- Hydrodynamic Characteristics of Towed and Self Propelled Submersibles
- Bubble and Turbulent Wake Characterization
- Dynamic Response of Structures to Underwater Explosive Shock
- Vehicle Control System Design Methodology Development
- Three Dimensional Graphics Simulation of Vehicle Dynamics
- Control System Design of Free-Swimming, Towed, and Autonomous Vehicles
- Advanced Diver Thermal Protection
- Low Probability Intercept Obstacle Avoidance Sonar
- CO2 Scrubber Technology
- Software Engineering Environments
- Computer Aided Engineering and Manufacturing
- Local Area Networks
- Fleet Support Diving System
- EOD Diver Support Projects
- MK 12 Surface Supplied Diving System (SSDS)/MK 1 Lightweight Diving Outfit (LWDO)
- Contaminated Water Diving System
- Chemical Warfare Protective Dive Suit
- Polar Operations Manual
- Gas Analysis
- Environmental Reaction Chamber

MAJOR ACCOMPLISHMENTS

WARFARE ANALYSIS

- An in-depth CNO sponsored analysis of the effectiveness of mine countermeasures force levels and employment concepts was completed. This effort provides the Navy with an assessment capability of the planned mine countermeasures forces to support expected Naval operations in 1995 and beyond. The study highlighted shortcomings and recommended necessary changes in the size of the force, its distribution, and its tactical capabilities. The study was guided by a select Flag Level Advisory Committee assuring that all aspects of the problem were considered. The study results will guide the Navy's acquisition of MCM ships, helicopters, and equipment

- Development of the draft Naval Warfare Publications and Combat System Doctrine for MCM-1 Class Ships represented a "first" for the Center in this kind of undertaking. Publication coincided with the training of the AVENGER's crew and initial Fleet acceptance trials and provided the unique expertise to ensure operational readiness.

- Support was provided to CNO (OP-095 and OP-031) in the development of top level NSW Program requirements. Baseline Area Appraisal (BAA), Warfare Task Appraisal (WTA), NSW Master Plan, and the NSW Systems R&D Master Plan. The diversity of NSW missions and tasks requires that NSW forces be capable of operating against a wide variety of enemy forces, threat sensors, and threat weapons

- Effectiveness and cost analyses for Development Option Paper (DOP) concerning the next generation of Navy amp ibious watercraft were completed. Fourteen conceptual alternatives were evaluated in detail. The DOP is presently in review at NAVSEASYSCOM.

SPECIAL WARFARE

- The comprehensive NSW R&D Master Plan was updated for FY88 through FY92. This plan identifies subject areas and established priorities for the research and development thrusts in the Special Warfare community over a five year period. The R&D Master Plan, under review by NAVSEASYSCOM and OPNAV, identifies advanced/engineering development. and Tech Base dollars throughout the Five Year Defense Plan to support this effort.

- A MK VIII Sea, Air, and Land (SEAL) Delivery Vehicle (SDV) Product Improvement Program and an Advanced SEAL Delivery System Program were initiated. These provide a design for current SDVs with enhanced reliability/maintainability and a concept of future delivery systems based on operational requirements

- Support for the NSW Mobility Improvement Program was provided to enhance performance and reliability of Fleet deployed SDVs. To date seven SDVs have been groomed and delivered to the Fleet.

- Waterside Security Systems (WSS) support was provided to evaluate off-the-shelf commercial and military equipment. Additionally, a Waterside Security Systems Five Year Plan, FY 87 to FY 92, was also developed for NAVSEASYSCOM.

MAJOR ACCOMPLISHMENTS

MINE COUNTERMEASURES

NAVCOASTSYSCEN efforts in Mine Countermeasures provide defensive capabilities to address threats to our Fleet assets. Specific accomplishments include:

- Combat system equipment was installed on the MCM-1 AVENGER. System equipment passed tests with minimal problems.

- Completed installing the New Generation Minehunting Sonar (AN/SQQ-30) aboard the MSO FIDELITY at NAVCOASTSYSCEN to begin contractor demonstration. The AN/SQQ-32 minehunting sonar will be installed on the last five MCM-1s and all seventeen of the MHC-51s.

- The AN/SSN-2 (Precise Integrated Navigation System) Command & Control system for the MCM-1 has been transitioned from the AN/UYK-20 computer to the new AN UYK-44 computer. At-sea technical testing was so successful that OPNAV cancelled the planned operational testing and will grant approval for production.

- Completed successful pre-certification test of the prototype COOP Combat Systems equipment. These equipments include Hyperfix, Sonar and Tactical Display.

- Completed acceptance tests and delivered New Generation Influence Minesweeping Systems, the AN/SLQ-37 (V3), to MCM - 2, 3, and 5, and to one MSO.

SONAR & TORPEDO COUNTERMEASURES

Completed TECHEVAL for the External Counter measure Launcher System (CFSA MK-2 Mod 1) for SSN 637 Class submarines and the advanced torpedo countermeasure (ADC MK-3). The CSA MK-2 represents the first capability to launch 6-inch diameter devices from attack submarines and is expected to provide the means of countering projected sonar and torpedo threats. Further advances were also made in the development of expendable countermeasures by the completion of the advanced torpedo countermeasure (ADC MK-2 Mod 1), an improvement to the smaller Fleet version countermeasure and the advanced development model ADC MK-4, an advanced sonar countermeasure.

MAJOR ACCOMPLISHMENTS

AMPHIBIOUS WARFARE

NAVCOASTSYSCEN efforts in Amphibious Warfare will provide U. S. Navy with an amphibious assault capability previously unavailable to U. S. forces.

- Technical support to LCAC Test and Trials Program culminated in successful TECHEVAL, OPEVAL, and FOT&E resulting in OPTEVFOR recommendation for approval for full production of LCAC.

- Bay and Gulf launch tests of Amphibious Assault Vehicles (AAVs) from LCACs were completed and verified ability of hullborne LCAC to discharge light and combat loaded AAVs from stern ramp.

- LCAC interface trials held with the Landing Dock LSD-38 class and LSD-41 class. LCAC deployment modifications also completed for USS DULUTH (Landing Platform Dock, LPD-6). These modifications will be made for other LPDs.

MARINE CORPS SUPPORT

NAVCOASTSYSCEN provides extensive support to the Marine Corps in developing amphibious assault systems. These systems will contribute to minimizing personnel and equipment losses. Technical program accomplishments include:

- Initiated Advanced Devlopment tests of the Catapult Launched Fuel Air Explosive (CATFAE).

- Initiated Engineering Development of an Anti-Personnel Obstacle Breaching System.

DIVING & SALVAGE

- A fully functional prototype of the Conventional Dive System (CDS) (EX-19),a mobile, free swimming, lightweight, circuit, electronically computer controlled rebreather backpack and passive diver thermal protection system, was delivered tc the Navy Experimental Diving Unit for testing after a successful acceleration of the program to meet SPECWAR requirements. The significance of the EX-19 effort is that not only will it provide a quantum advance in life support technology and performance, but for the first time a single underwater breathing apparatus will meet the needs of Explosive Ordnance Disposal, Special Warfare, and the Fleet diver.

- The Contaminated Water Diving System (CWDS), (U.S. Army sponsorship), will provide the capability to operate in contaminated environments while protecting both diver and topside personnel from chemical and thermal hazards. Numerous commercial pieces of hardware for diver and topside use have been procured, modified by NAVCOASTSYSCEN to improve performance, and undergone testing to establish their effectiveness. Preliminary deployment procedures have been established and will be finalized during FY 88. A unique chemical data base has been established which will be used in conjunction with the deployment procedures to ensure all contingencies, operational and emergency, have been considered prior to initiating diving operations. Prototype protective diving suits will be fabricated during FY 88. This program and its associated technology will serve to greatly enhance the U.S. Army's flexibility in responding to various hazardous waste diving scenarios.

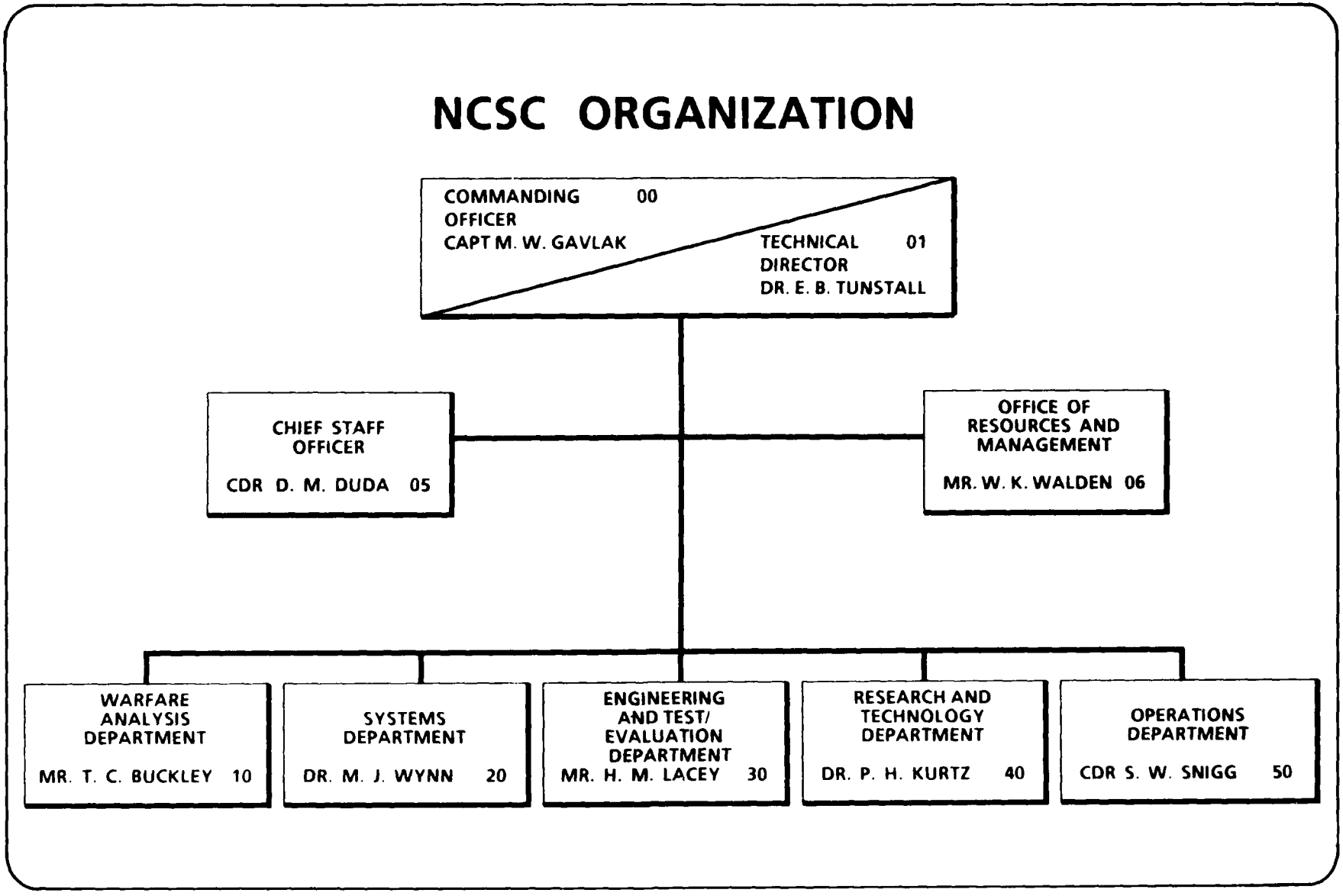
MAJOR ACCOMPLISHMENTS

- The Fire Fighter's Breathing Apparatus (FFBA) is a life support component of an improved personnel protective ensemble to be worn by fire fighting (FF) and damage control (DC) personnel for their operations. The FFBA will provide an improved life support component to personnel conducting operations in hazardous shipboard environments and will increase the duration, safety, and effectiveness of missions conducted by FF/DC personnel. This system will increase the Navy's capability to fight shipboard fires and reduce casualties and damage resulting from fires. Recent accomplishments include development of a Full Scale Engineering Development procurement package and completion of unmanned testing on NAVCOASTSYSCEN's in-house advanced development model.

RESEARCH & TECHNOLOGY

- The Magnetic / Acoustic Detection of Mines (MADOM) concept was augmented and modified for open-ocean testing out of Norfolk. The purpose of these tests was to determine the nature and quantity of bottom clutter. Magnetic and acoustic data against the bottom clutter were taken on more than 100 miles of towing around Norfolk. Tests to measure background clutter are required in order to determine the capability of MADOM. The Norfolk data analysis will give the first indication of the capability of MADOM in an operational scenario.

- The navigation guidance, control autonomous logic, data recording, and system integration of a large scale vehicle under contractor development in support of the SSN-21 program, is being conducted by NAVCOASTSYSCEN. During FY 87 this work progressed to a level permitting the PMS 350 certification team to conduct a complete review of hardware and software readiness, including demonstration through hybrid simulation (guidance hardware in the loop) of the control and logic for the Large Scale Vehicle (LSV). NAVSEASYSCOM review of this work has produced very favorable response and has established readiness of the system for at-sea testing. The effort includes a digital simulation which is used extensively by the vehicle developers in support of the design effort. The LSV will become a national asset in support of future submarine research and development.


NCSC ORGANIZATION
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TECHNICAL DIRECTOR 01
DR. E. B. TUNSTALL
CHIEF STAFF OFFICER
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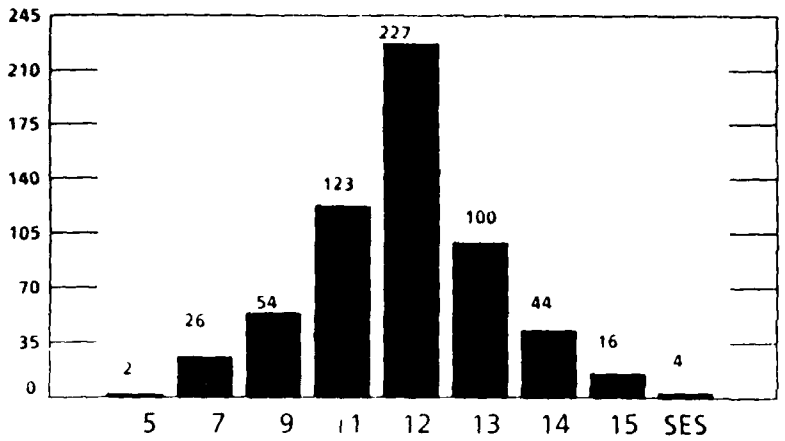
MR. T. C. BUCKLEY 10
SYSTEMS DEPARTMENT
DR. M. J. WYNN 20
ENGINEERING AND TEST/ EVALUATION DEPARTMENT
MR. H. M. LACEY 30
RESEARCH AND TECHNOLOGY DEPARTMENT
DR. P. H. KURTZ 40
OPERATIONS DEPARTMENT
CDR S. W. SNIGG 50

NCSC

PERSONNEL

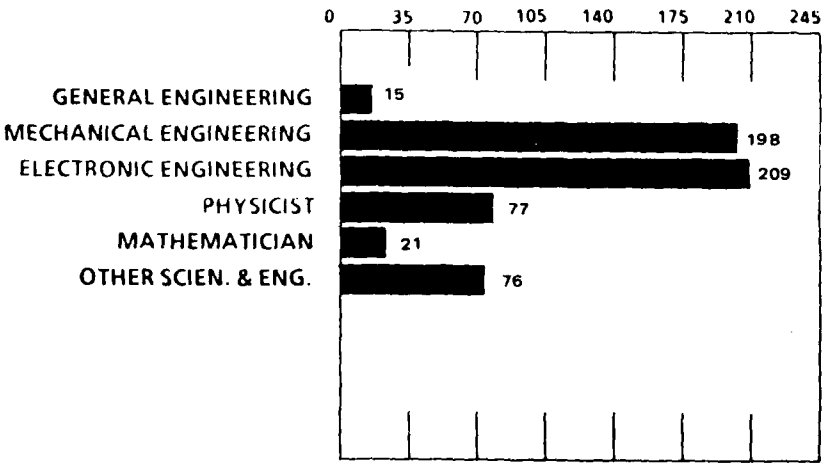
TOTAL ON BOARD	TOTAL MILITARY	TOTAL CIVILIAN	FTP*	TPTI**	FTP UNGRADED	FTP* GRADED
1361	133	1228	1172	56	149	1023

SCIENTISTS & ENGINEERS (BY GRADE)



SCIENTISTS & ENGINEERS	596
ADMINISTRATIVE	127
TECHNICIANS	143
OTHER GRADED	157

BY DISCIPLINE



CIVILIAN END STRENGTH FY87		1228
BUDGETED END STRENGTH FY88		1218
BUDGETED END STRENGTH FY89		1203
MILITARY ALLOWANCE		129
OFFICER	16	
ENLISTED	113	

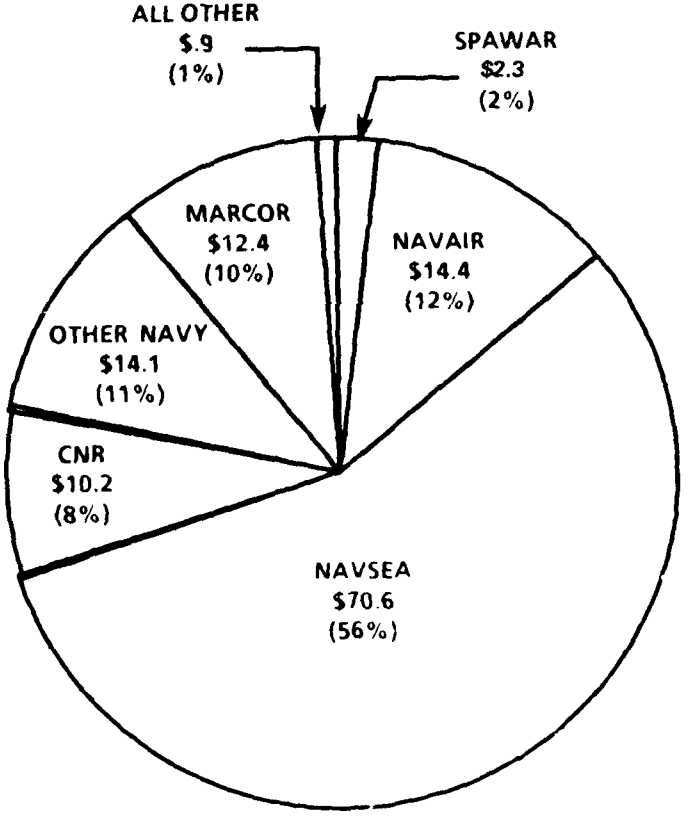
* FULL-TIME PERMANENT
** TEMPORARY, PART-TIME, INTERMITTENT

30 SEPTEMBER 1987

NOR
$ IN MILLIONS

SOURCE OF FUNDS
FY 87

ACTUAL $124.9*



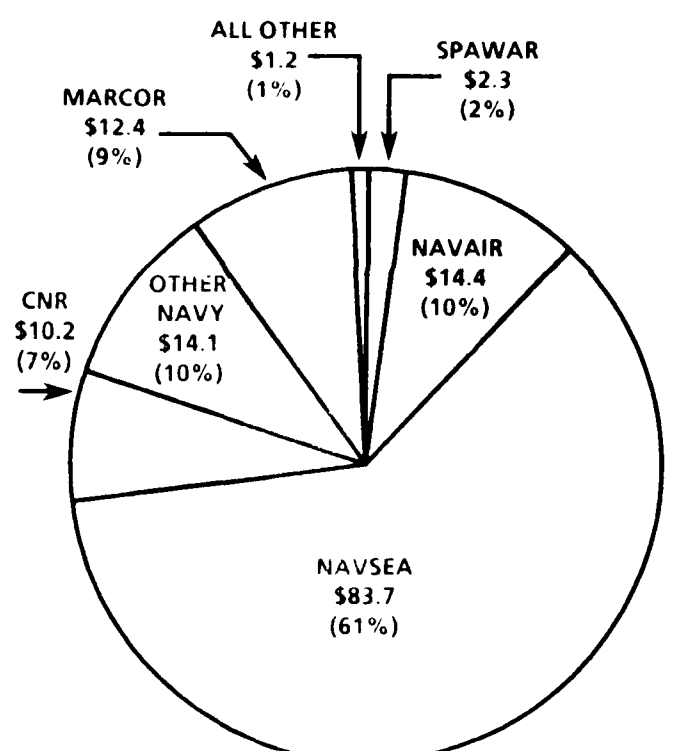
*DIRECT CITE FUNDS $26.4M

NCSC

SOURCE OF FUNDS

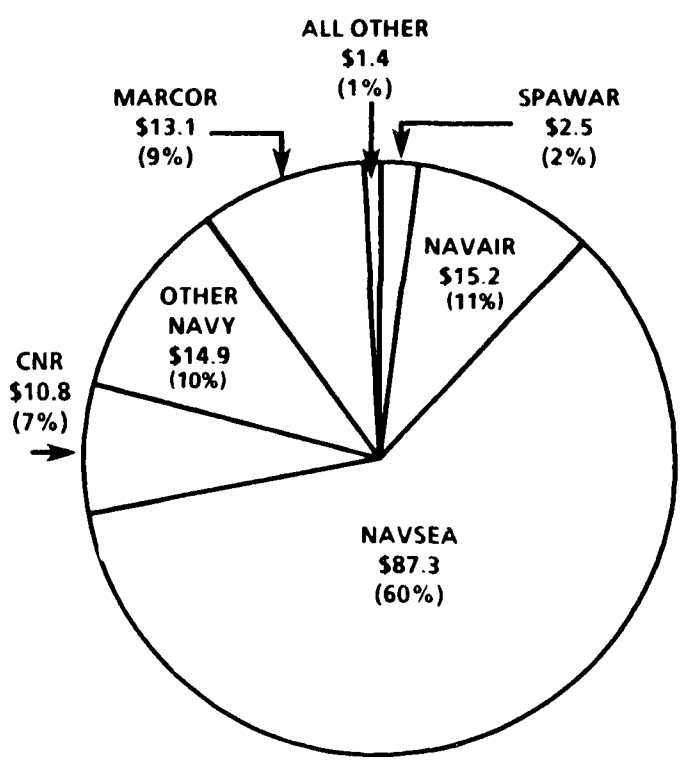
NOR
$IN MILLIONS

FY88 PLANNED $138.3*



*DIRECT CITE FUNDS $29.2M

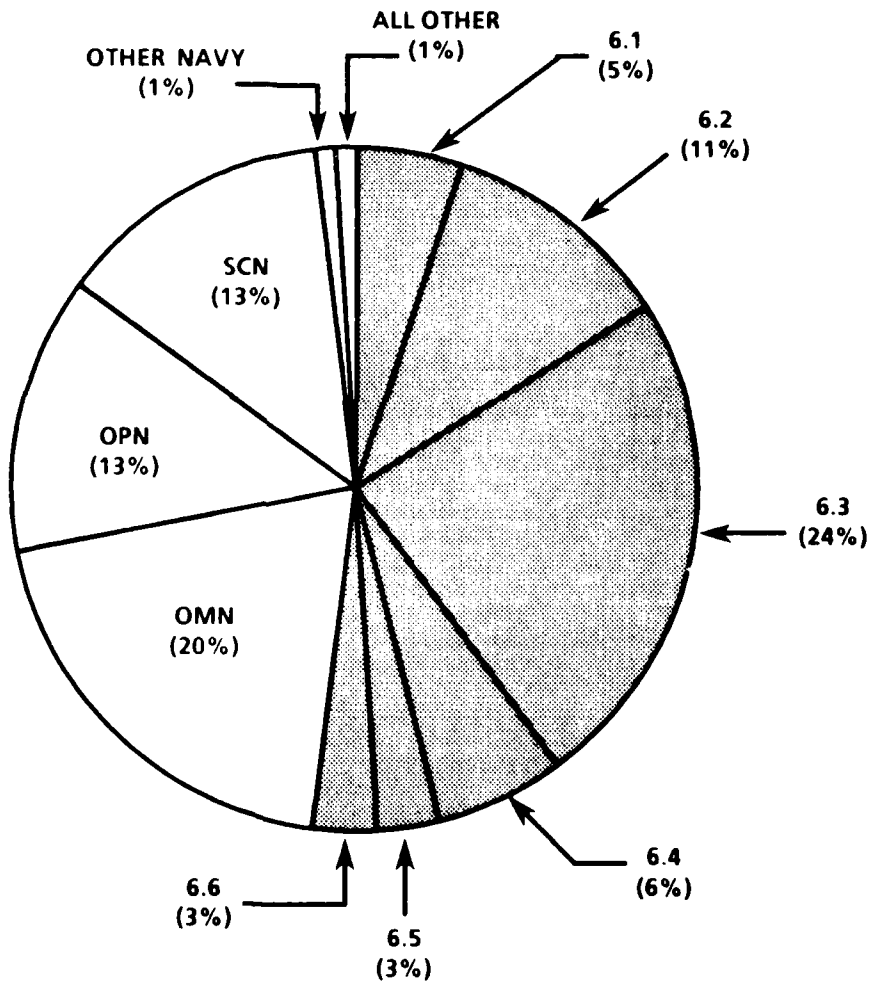
FY89 PLANNED $145.2*



*DIRECT CITE FUNDS $26.3M

NOR
$ IN MILLIONS

FUNDING BY APPROPRIATION
FY 87

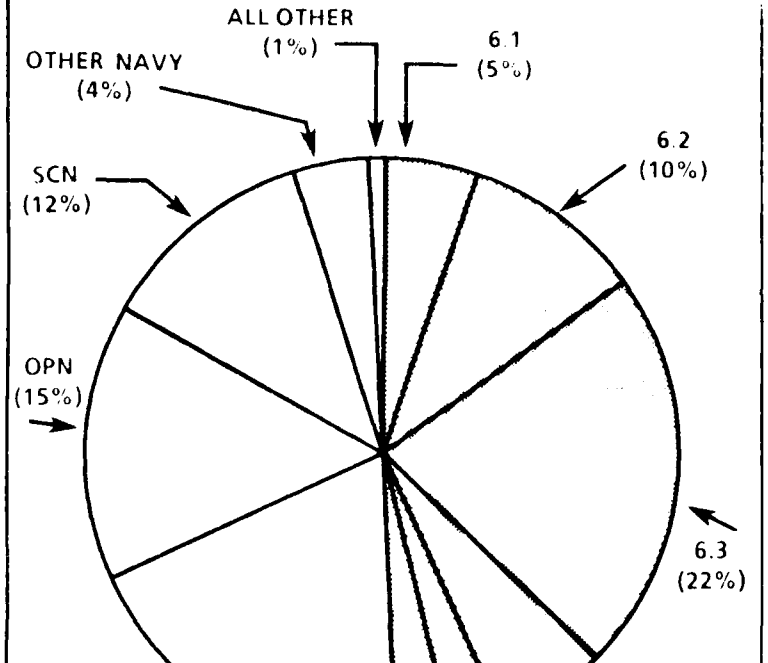


NCSC

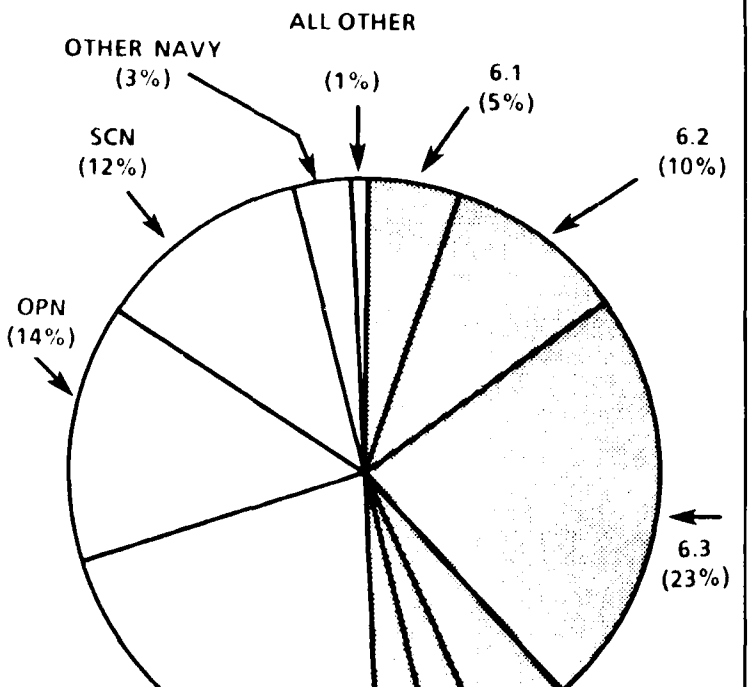
FUNDING BY APPROPRIATION

NOR
$IN MILLIONS

FY 88



FY 89



NCSC

FUNDS BY CATEGORY AND TYPE

NOR
$ IN MILLIONS

CATEGORIES & TYPE	FY87 $M (Actual)	FY87 % OF RDT&E	FY87 % OF Total	FY88 $M EST.	FY88 % OF RDT&E	FY88 % OF Total	FY89 $M EST.	FY89 70% OF RDT&E	FY89 70% OF Total
RDT&E, N (CATEGORY)									
6.1 Research	6.5	10.0	5.0	6.5	9.7	5.0	6.8	9.7	5.0
6.2 Exploratory Development	13.4	20.7	11.0	13.4	20.0	10.0	14.0	20.0	10.0
6.3a Advanced Technology Development	0	0	0	0	0	0	0	0	0
SUBTOTAL	19.9	30.7	16.0	19.9	29.7	15.0	20.8	29.7	15.0
6.3b Advanced Development	29.4	45.4	24.0	30.2	45.2	22.0	33.1	47.2	23.0
6.4 Engineering Development	7.0	10.8	6.0	8.3	12.4	6.0	7.4	10.6	5.0
6.5 Management and Support	4.1	6.4	3.0	4.1	6.2	3.0	4.3	6.1	3.0
6.6 Operational Systems Development	4.3	6.7	3.0	4.3	6.5	3.0	4.5	6.4	3.0
RDT&E, N SUBTOTAL	64.7	100.0	52.0	66.8	100.0	49.0	70.1	100.0	49.0
Other Appropriation									
(O&MN) Operation & Maintenance, Navy	25.6	-	20.0	28.3	-	19.0	31.0	-	21.0
(OPN) Other Procurement, Navy	15.8	-	13.0	20.1	-	15.0	21.1	-	14.0
(SCN) Shipbuilding & Conversion, Navy	16.5	-	13.0	16.5	-	12.0	17.3	-	12.0
Other Navy	1.4	-	1.0	5.7	-	4.0	4.7	-	3.0
All Other	.9	-	1.0	.9	-	1.0	1.0	-	1.0
OTHER APPRORPRIATION SUBTOTAL	60.2	-	48.0	71.5	-	51.0	75.1	-	51.0
CENTER TOTAL	124.9	-	100.0	138.3	-	100.0	145.2	-	100.0

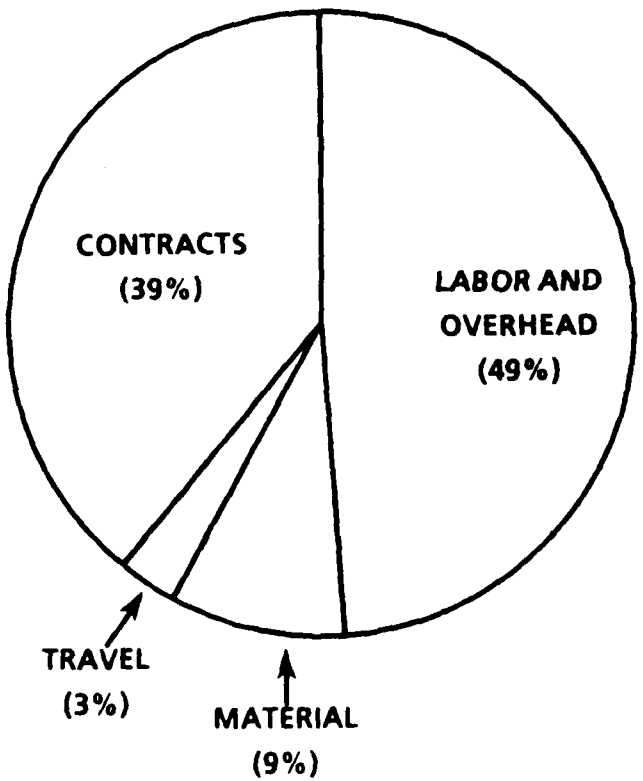
Direct Cite Funds $26.4M

30 SEPTEMBER 1987

NCSC

NOR
$IN MILLIONS

DISTRIBUTION OF FUNDS
FY 88 ESTIMATED



LABOR & OVERHEAD	67.7
MATERIAL	12.5
TRAVEL	4.2
CONTRACTS	53.9
TOTAL	138.3

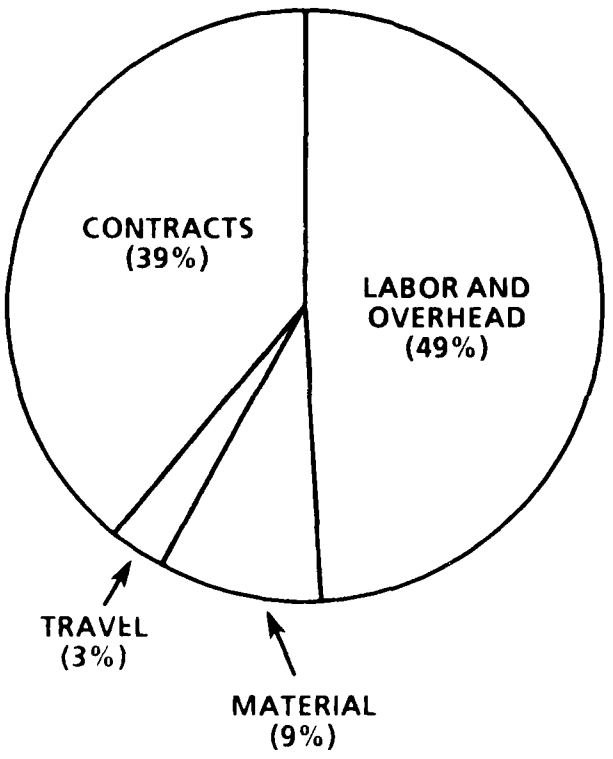
30 SEPTEMBER 1987

NCSC

DISTRIBUTION OF FUNDS

FY 89 ESTIMATED

NOR
$ IN MILLIONS



LABOR & OVERHEAD	71.1
MATERIAL	13.1
TRAVEL	4.4
CONTRACTS	56.6

TOTAL	$145.2

30 SEPTEMBER 1987

NCSC

LEADERSHIP ASSIGNMENTS

NAVCOASTSYSCEN is responsible for Navy wide Leadership in:

a. Undersea Countermeasures

b Mine Countermeasures

c. Torpedo and Sonar Countermeasures

d. Ship / Airborne Mine Countermeasures Combat System Integration

e. Submarine Launchers (Countermeasures Unique)

f. Special Warfare

g. Amphibious Warfare

h. Diving and Salvage

As assigned by NAVMAT Instruction 5450.27C of 1 August 1983.

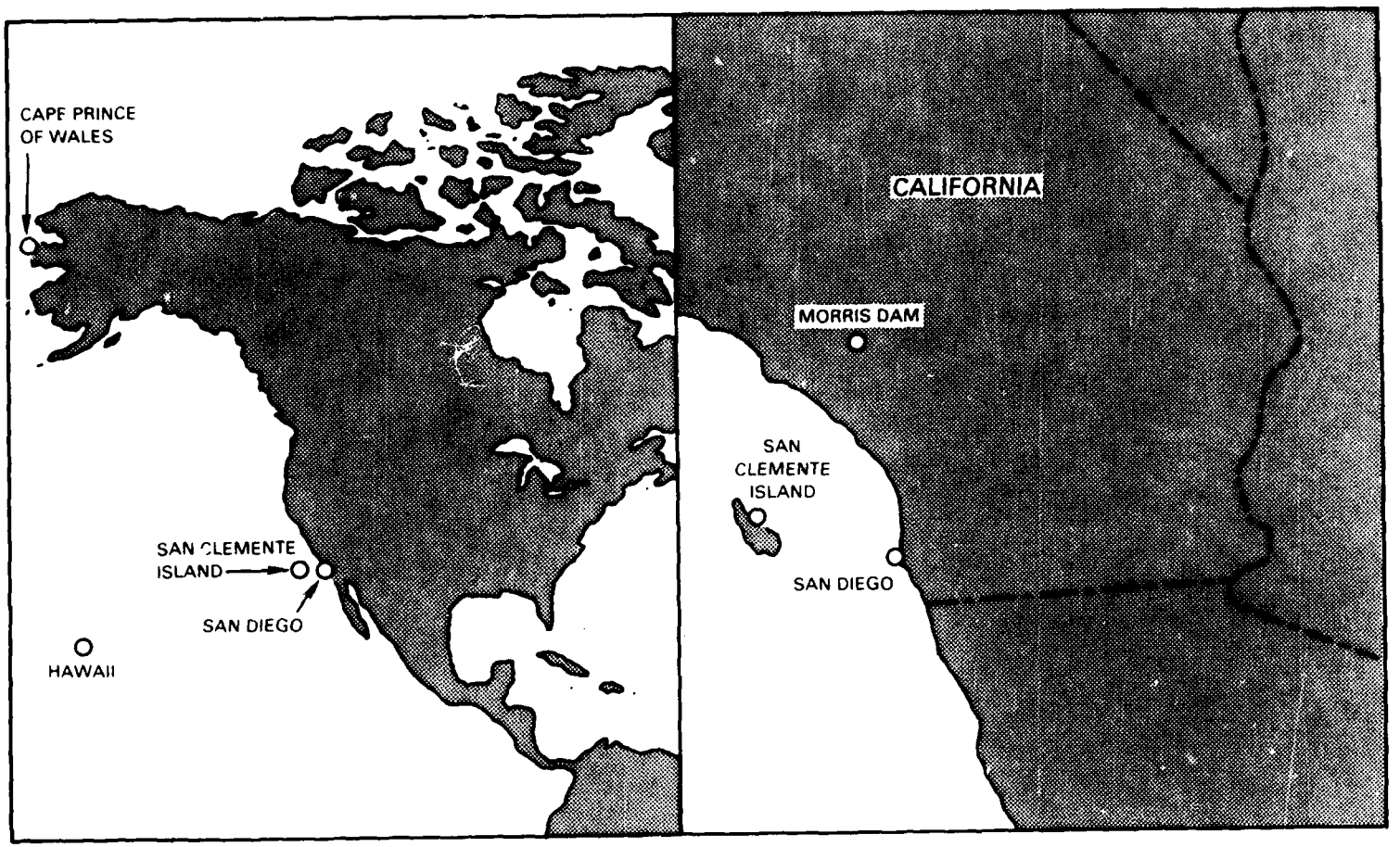
Naval Ocean Systems Center

Brief

San Diego, California
30 September 1987

NOSC

NOSC FACILITIES



30 SEPTEMBER 1987

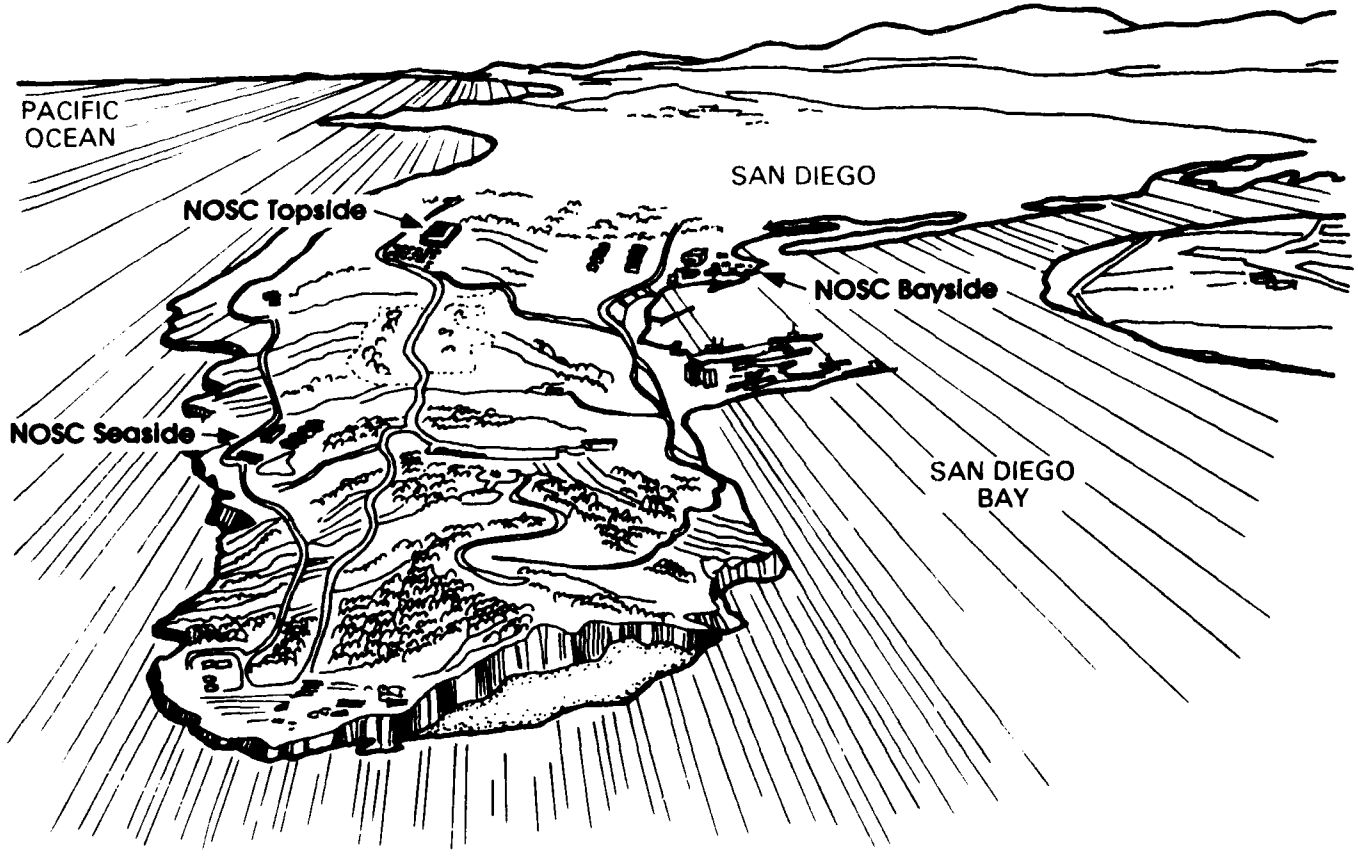
NOSC

NAVAL OCEAN SYSTEMS CENTER

San Diego, California 92152-5000

E.G. SCHWEIZER, CAPT, USN
Commander

R.M. HILLYER
Technical Director



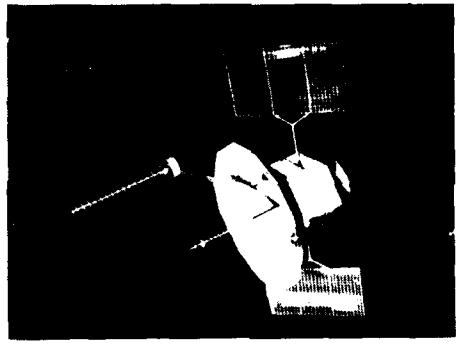
30 SEPTEMBER 1987

NOSC

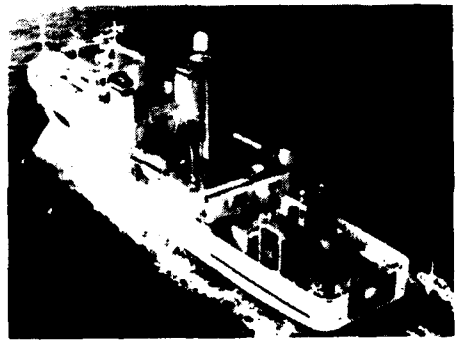
MISSION

To be the principal Navy RDT&E Center for Command Control, Communications, Ocean Surveillance, Surface- and Air-launched Undersea Weapons Systems, and Submarine Arctic Warfare.

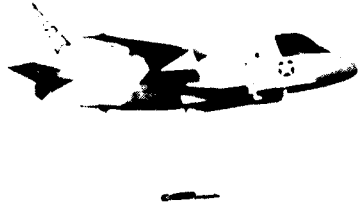
Command Control



Communications



Ocean Surveillance



Surface- and Air-launched Undersea Weapons Systems

Submarine Arctic Warfare

30 SEPTEMBER 1987

NOSC

INTRODUCTION TO THE NAVAL OCEAN SYSTEMS CENTER

The Naval Ocean Systems Center (NOSC) is a full-spectrum research, development, test, and evaluation (RDT&E) center serving the needs of the Department of the Navy and the Department of Defense within assigned mission and leadership areas. We provide solutions to Naval and Joint Service problems through the generation and application of technology. Our role is to provide innovative alternatives to tomorrow's decision makers, thus enabling them to pursue new or expanded missions. NOSC is part of a team involving the Systems Commands, the Office of the Chief of Naval Operations, the Fleet, the Offices of Naval Research and Technology, academia, and industry. NOSC operates under the guidance of the Space and Naval Warfare Systems Command (SPAWAR).

NOSC assumes technical leadership for developing systems and solutions. Our principal role is to provide the Navy team with "smart buyer" support in the systems acquisition process as a Technical Agent of the Systems Commands. NOSC focuses on the Navy's future needs and is uniquely capable of serving the Fleet in times of national crises. Specifically, we support systems for which we share a responsibility during introduction into the Fleet and provide technical expertise and facilities not readily available to operational commands. Our strong commitment to close liaison with the Fleet ensures that our efforts remain relevant. Our role now, and for the future, is to direct and create technology, oversee technology transition, initiate programs, act as Technical Direction Agent, support test and evaluation, and transition our products to other commands for production and in-service support.

NOSC performs RDT&E in these major areas:

- Command control and communications
- Ocean surveillance
- Antisubmarine warfare
- Ocean sciences
- Ocean engineering
- Submarine arctic warfare
- Intelligence support systems
- Biosystems research
- Support technologies, including integrated circuit design and fabrication

NOSC's work force includes 3071 full-time civilian employees as well as a military allowance of 61 officers and 213 enlisted personnel.

Total funding authority in FY 1987 was $547 million and is estimated to be approximately $525 million in FY 1988.

Primary facilities are in San Diego, California. Additional facilities include a laboratory at Kaneohe Bay, Oahu, Hawaii; sea ranges at San Clemente Island; a test range at Morris Dam, California; and an arctic field station at Cape Prince of Wales, Alaska.

Real property and equipment assigned to NOSC have a plant account value of approximately $188.6 million.

NOSC

MAJOR FACILITIES AND RESOURCES

SAN DIEGO

NOSC occupies more than 500 acres of land on the Point Loma peninsula, approximately 7 miles from downtown San Diego. Facilities are concentrated in three major areas: Topside, Bayside, and Seaside.

NOSC Topside, located on the ridge of Point Loma, includes the principal administrative and support sections, as well as facilities for communications, environmental testing, electronic materials, advanced electronics, laser technology, and ocean surveillance.

NOSC Bayside faces San Diego Bay, which provides the waterfront access and berthing capabilities vital to NOSC activities in undersea weapons and marine sciences. McLean Laboratory and the Ocean Sciences Laboratory are located bayside.

NOSC Seaside, located on the west slope of Point Loma, offers a protected, electromagnetically shielded site essential to RDT&E in command control and communications (C^3) and ocean surveillance. The Command and Control Systems Laboratory, proposed for FY 1989, will provide the ability to recognize system integration problems early in the development process. RDT&E will be conducted on a single or multiplatform basis using real-time simulation techniques with the actual platforms.

Major facilities grouped by program areas:

COMMAND CONTROL AND COMMUNICATIONS (C^3) (Lead Laboratory)

Command and Control

- Land-based prototype of the Tactical Flag Command Center (TFCC)/Flag Data Display System (FDDS), a complete mockup of a CV-66-class command center including displays, used for development support and training.
- Battle Group Tactical Trainer (BGTT)/Research, Evaluation, Simulation, and Analysis (RESA) facility, a computer-based training aid and analysis tool for analysis of strategy and tactics in Battle Group operations.
- Desktop computer laboratory, a local area network of microcomputers and displays for rapid prototyping experimentation.
- Navy Front End Processor (NFEP) facility for developing and integrating hardware and software for Defense Data Network (DDN) connectivity to Navy Command and Control Systems (NCCS) ashore sites.
- JTU Development and Integration Facility (JDIF) for developing and integrating hardware and software for the JINTACCS/Rainforrn Translator Unit (JTU).
- Command Control and Communications Systems Integration Test and Evaluation Site (C^3 SITE), permitting development, integration, and testing of complete electronic systems in a controlled environment, both electromagnetically and physically secure.

NOSC

MAJOR FACILITIES AND RESOURCES

(continued)

- Advanced development laboratory with RFI-shielded, vault-level security, and capability to receive and process data from various sources through on-line communications.
- World-Wide Military Command and Control System (WWMCCS) Information System (WIS) test and integration facility for test and evaluation of terminal communications equipment for Navy-operated WWMCCS sites.
- Standard Embedded Computer Resources (SECR) laboratory to support testing and evaluation of Navy standard computer products.
- SECR VAX 11/785 for Ada language system and Ada language programming support environment.
- Command control architectural test bed for evaluating distributed command control systems.
- Combat Direction System Development and Evaluation Site (CDES), a secure facility for development of the Advanced Combat Direction System (ACDS) Block 0 aircraft carrier system, ACDS Block 1, and command and control processor for carriers and cruisers.

Communications

- VLF/LF test bed for development and evaluation of new or modified capabilities in support of the minimum essential emergency communications network (MEECN), with emphasis on submarine communications systems development.
- EHF satellite communications terminal test bed for ship, submarine, and shore site terminal TECHEVAL and follow-on support of equipment and software development and testing.
- Integrated Communication System (ICS)/Shipboard Communications Area Net (SCAN) demonstration and validation laboratory.
- Ship antenna model range for HF/VHF/UHF antenna design and topside arrangement.

OCEAN SURVEILLANCE (Lead Laboratory)

- Ocean Surveillance Laboratory with RFI-shielded, vault-level security and capability to receive and process data from various sources through on-line communications.
- Surveillance Test and Integration Center (STIC) supporting the Integrated Undersea Surveillance System (IUSS) (including Surveillance Towed Array Sensor System (SURTASS) and Sound Surveillance System (SOSUS)), Low-Frequency Active (LFA), Fixed Distributed System (FDS), ARIADNE, and Surveillance Direction System (SDS) and providing a test bed for the support of software development, integration, developmental verification and validation testing, life-cycle support, data acquisition, and real-time signal processing and display.

NOSC

MAJOR FACILITIES AND RESOURCES
(continued)

- Signals warfare support facility, providing a secure EMI/EFI area for analysis, system development, test, and evaluation of countercommunications, signals intelligence (SIGINT) and signals security (SIGSEC), and related cryptologic programs.
- Transducer Evaluation Center (TRANSDEC), a sonar calibration pool that is anechoic at all frequencies.
- Microwave and millimeter-wave antenna-pattern range complex.

UNDERSEA WEAPON SYSTEMS

- Antisubmarine warfare systems (ASW) facility for developing new contact management and weapon control functions, testing prior to Fleet introduction, and continuing Design Agent (DA) support.
- Development and test facility for ASW missile system performance and hardware evaluation in real-time environment. Three-axis motion simulator with continuous roll capability.
- Undersea Weapons Laboratory for RDT&E of advanced lightweight antisubmarine torpedoes.
- Development and test facilities for lightweight surface- and air-dropped torpedoes and for submarine-launched missiles including the Torpedoes MK 46 and MK 50 and the Vertical Launch Antisubmarine Rocket (VLA).
- A real-time hardware-in-the-loop simulation facility combining torpedo guidance-and-control hardware with digital and analog computers for RDT&E of underwater weapons, including the MK 46, MK 48 Advanced Capability (ADCAP), and MK 50.
- Water tunnel for basic hydrodynamic research in turbulent-boundary-layer phenomena for application to underwater bodies.
- Pipe flow facilities for studies of drag reduction by turbulence manipulation, degradation of polymer solutions at high-shear rates, and scaling parameters.
- Satellite production test facility for the ASW Control System (ASWCS).
- USS DOLPHIN (AGSS 555), a unit of Submarine Development Squadron One, used for research and development of advanced sonar equipments and systems.

SUBMARINE ARCTIC WARFARE (Lead Laboratory)

- Arctic Submarine Laboratory, including experimental pool and sea-ice model basin for study of sea-ice physics, under-ice environment, and related submarine under-ice operations; also includes high- and super-high-pressure test facilities.

NOSC

MAJOR FACILITIES AND RESOURCES
(continued)

MARINE SCIENCES

- Ocean Sciences Laboratory with special facilities for work with marine organisms; labs for chemical oceanographic research; labs including analytical instrumentation facilities for environmental research and monitoring; chemistry and biochemistry labs for nonmedical biotechnology studies; RFI-shielded labs for lasers and microelectronics systems.
- Bioscience Facility, for physiological research, training, and handling of marine animals to perform naval tasks in the open ocean.

DESIGN ENGINEERING, TESTING, AND PROTOTYPE DEVELOPMENT

- Environmental test laboratory for performing shock, vibration, climatic conditions, EMI/RFI, salt-spray, and hydrostatic testing of military products.
- Structural Materials Sciences Laboratory, including automated optical emission spectrometer, scanning electron microscope, advanced image analyzer, automated accelerated corrosion test facility, and 150-channel automated data acquisition and reduction facility.
- Facility for prototype hardware fabrication, which includes the Navy Laboratories' only premium quality, light alloy foundry.
- Computer-aided design, engineering, and analysis tools for Center engineers.
- Calibration laboratory for electronic test equipment.
- Facility for design, engineering, and prototype hardware assembly/checkout to support teleoperator/remote presence system development.

ELECTRONIC SCIENCES AND TECHNOLOGY

- Microelectronics Laboratory Complex, which includes a computer-aided design and a small-lot fabrication capability for producing custom and experimental devices.
- Electronic Materials Sciences Laboratory, including facilities for research on III-V semiconductor compound and alloy technology and fiber-optics technology, as well as a Tri-Service facility for infrared detector and focal plane array evaluation.
- Electro-optics facility consisting of laser laboratories, indoor and outdoor optical test ranges, laboratories for constructing and testing ocean optic measurement equipment, and a generalized optics system fabrication shop.

COMPUTER SUPPORT

- A computer facility consisting of DEC minicomputers and a CONVEX minisupercomputer that provides scientific and business computing as well as real-time simulation support.

NOSC

MAJOR FACILITIES AND RESOURCES
(continued)

HAWAII

The Hawaii Laboratory is located at the Marine Corps Air Station on Kaneohe Bay, Oahu. This 20-acre facility provides a mid-ocean base for Center fleet support activities and programs in command control and communications, marine biosystems, ocean bionics, ocean surveillance, ocean technology, and teleoperator/remote presence systems. The area is particularly suited for tasks requiring humans to spend long periods in water. Animal handling and training facilities are located in the bay, with support facilities located nearby. A complete measurements laboratory exists for the developmental testing of optical fibers, cables, sources, and detectors combining precision optical instrumentation and simulated deep-sea environmental conditions of temperature and pressure. The Stable Semisubmerged Platform (SSP) KAIMALINO, a small (228-ton), highly stable, range support craft provides smooth operation in high sea states. A deep-water, off-shore test facility allows in-situ fiber-optic system testing with a full complement of optical instrumentation. Deep waters close to shore also provide an advantageous site for both ocean engineering and undersea surveillance systems testing. A facility for design, engineering, and prototype hardware assembly/checkout supports teleoperator/remote presence system development.

MORRIS DAM

The Morris Dam Facility near Azusa, California, includes the Morris Dam Reservoir and adjacent land. This 640-acre area, leased from the Metropolitan Water District of Southern California, is used for the development and testing of underwater ordnance. Facilities include the variable-angle launcher, slingshot launcher, helicopter range for torpedo drops, propulsion laboratory, static test cells, and a polymer flow facility.

SAN CLEMENTE ISLAND

San Clemente Island (SCI), located 65 miles west of San Diego, is the site of a major NOSC test range. This island and surrounding waters are equipped with special and general purpose test and sea range facilities, instrumentation, and communications. The Center uses SCI for test and evaluation of NOSC-developed and other Navy weapons and systems. Among the special facilities at SCI is an underwater launch facility for HARPOON and TOMAHAWK. Administrative control of the island is exercised by the Commanding Officer, Naval Air Station, North Island.

ALASKA

Located at Cape Prince of Wales is an arctic field station for continuing study of sea ice and arctic seas. Instrumentation systems monitor oceanographic, meteorological, and sea-ice conditions on a year-round basis.

NOSC PROPERTY

Land Owned/Leased	2719 acres
Buildings	
RDT&E	1,368,100 sq ft
Administrative	202,800 sq ft
Other	201,233 sq ft
Acquisition Costs	
Real Property	
(Classes I and II)	$66.2 million
Equipment	
(Classes III, IV, and V)	$122.4 million

NOSC

HISTORICAL DEVELOPMENT OF NOSC

BEGINNINGS IN POINT LOMA

Although the two main predecessors of the Naval Ocean Systems Center have only existed as RDT&E centers since World War II, a tradition of Navy activity on the Point Loma site actually began with the commissioning in 1906 of the Navy Radio Station, Point Loma. More importantly, this location later was chosen by the Navy in 1940 to be the site of its first west coast laboratory, the U.S. Navy Radio and Sound Laboratory.

The initial work of the new laboratory was to test new radar equipment in the secure and interference-free location provided by Point Loma. During the war, the work of the Radio and Sound Laboratory extended to other aspects of radar and radio communications, notably electronic architecture.

UNIVERSITY OF CALIFORNIA TO NEL

Beginning in 1941, civilian scientists worked at the laboratory under the auspices of the University of California Division of War Research (UCDWR). Work focused on antisubmarine warfare, training systems for sonar operators, and support of U.S. submarine operations, in addition to basic research on underwater acoustics and oceanography. UCDWR and the Radio and Sound Laboratory activities were combined in 1945 into a single organization, the Navy Electronics Laboratory (NEL). During the next 30 years, NEL developed a Navy-wide reputation for its work in radio, tactical warfare simulators, information display and data management systems, sonar, lasers, navigation, satellite communication, and radar.

Along with their fundamental supporting research in radio physics, oceanography, and electronic materials, NEL scientists developed techniques and instruments that enabled submariners to navigate under the Arctic ice. As a result of this work, NEL scientists were aboard NAUTILUS during its historic 1958 transit under the North Pole and aboard SKATE, when it surfaced at the North Pole in 1959.

Other well-known projects in which NEL participated were the Navy Tactical Data System (NTDS), the Navy Electronic Warfare Simulator (NEWS), the Omega Navigation System, the Fleet Operational Readiness Accuracy Check Sites (FORACS), and the TRIESTE's record achievement in 1960 of diving to a depth of 35,800 feet.

CAL TECH TO NUC

Concurrently with NEL development, scientists from Pasadena's California Institute of Technology (Cal Tech) conducted water-entry research under contract to the Navy to improve the air-dropped Torpedo MK 13. To test water entry of the torpedoes, the Cal Tech scientists constructed unique test facilities at Morris Dam, a reservoir east of Pasadena.

After the war, some of the Cal Tech group formed the Underwater Ordnance Department of the new Naval Ordnance Test Station (NOTS), at China Lake. Another group of Cal Tech scientists, those working in underwater ordnance,

NOSC

HISTORICAL DEVELOPMENT OF NOSC
(continued)

stayed in Pasadena to form an annex of NOTS. Over the next 20 years, NOTS underwater ordnance researchers led the development of the antisubmarine rocket (ASROC), the MK 44 and 46 lightweight torpedoes, and ASW fire control systems. In addition, NOTS Pasadena demonstrated the feasibility of launching Polaris missiles from underwater and developed the Navy's first remotely operated vehicle, the Cable-controlled Underwater Recovery Vehicle (CURV), which in 1966 recovered an H-bomb lost in the Mediterranean.

WEST COAST REORGANIZATION

In 1967, the Navy reorganized its west coast laboratories. NEL became the Naval Electronics Laboratory Center (NELC), with a new focus on command and control, communications, and electronic materials. NEL's ASW researchers joined the Underwater Ordnance Department of NOTS Pasadena to form the Naval Undersea Center (NUC), newly headquartered in San Diego. NUC's mission encompassed work in underwater ordnance and fire control, marine biosciences, remotely operated vehicles, ASW, oceanography, and the development of advanced technologies supporting its missions.

NOSC PROVIDES BROAD-SPECTRUM CAPABILITY

In 1977, NELC and NUC were consolidated as the Naval Ocean Systems Center to provide a broad-spectrum systems capability and to facilitate integration of major mission areas. Since that time, NOSC has achieved notable successes throughout its mission areas. Some of its notable programs have included developing the Mobile Submarine Simulator, a submarine countermeasures system; the Surveillance Towed Array Sensor System (SURTASS) for strategic ocean surveillance; and the Mine Neutralization System, a remotely operated minesweeping vehicle. Researchers in command and control developed and then deployed the Tactical Flag Command Center aboard six carriers. Other NOSC researchers demonstrated the feasibility of using lasers to communicate with submarines at operational depths. In addition, NOSC conceived and now directs the development of the Advanced Lightweight Torpedo (MK 50) and the Vertical Launch ASROC.

Today, NOSC continues to advance Navy RDT&E in the fields developed by its predecessors, evidenced by significant SPAWAR leadership assignments and by a wide spectrum of program work and accomplishments.

NOSC

MAJOR TECHNICAL PROGRAMS

As the principal Navy research, development, test, and evaluation center for command control, communications, ocean surveillance, surface- and air-launched undersea weapons systems, and submarine arctic warfare, NOSC program effort is directed towards the following:

COMMAND CONTROL AND COMMUNICATIONS (C^3) (Lead Laboratory)

Command and Control

- Provide systems engineering for the 1987-1995 Navy Command and Control Systems (NCCS) ashore and afloat.
- Provide systems engineering, lead ship development, and technical direction for the Advanced Combat Direction System (ACDS) and the Command and Control Processor as Technical Direction Agent (TDA).
- Provide systems engineering and development for the Tactical Flag Command Center (TFCC)/Flag Data Display System (FDDS).
- Design, develop, integrate, and install the JINTACCS/ Rainform Translator Unit (JTU) at major NCCS nodes ashore and afloat.
- Provide systems engineering for the Over-the-Horizon Targeting (OTH-T) Program (Lead Laboratory).
- Design, develop, test, and integrate the Research, Evaluation, Simulation, and Analysis (RESA) computer simulation and modeling facility.
- Provide technical and engineering support as Technical Agent in definition and development of the Battle Force Tactical Trainer (BFTT) and the Battle Force In-Port Training (BFIT) improvement program.
- Provide technical support for the Fleet Command Center Battle Management Program.
- Develop, install, test, and evaluate the Interoperability Test Network (ITN) as part of a Tri-Service experiment conducted by the Joint Directors of Laboratories.
- Provide architectural and systems engineering support to the Warfare Systems Architect/Warfare Systems Engineer.

Communications

- Provide system engineering, development, and T&E support for improved submarine broadcast and report-back communications.
- Provide system engineering and T&E support for Joint Tactical Information Distribution System (JTIDS) terminal development and Fleet deployment.
- Develop ship, submarine, and shore EHF satellite communications terminals for use with the MILSTAR SATCOM program.

NOSC

MAJOR TECHNICAL PROGRAMS
(continued)

- Determine feasibility of and develop a submarine laser communication system.
- Develop secure-conferencing capability to support the national and CINC-level command control process.
- Develop an advanced automated integrated communication system for the Fleet.
- Provide system engineering support for the Link 11 Upgrade and high-frequency antijam (HFAJ) program.
- Develop secure communications terminals and communication centers to support Navy, Marine Corps, and DoD theater requirements.
- Provide electromagnetic compatibility engineering for all shipboard electronics systems.
- Develop high-capacity SHF satellite communications capability, UHF satellite information exchange system, and satellite secure-voice console for Navy combatants and shore sites.

OCEAN SURVEILLANCE (Lead Laboratory)

- Develop advanced surveillance technologies, including signal and image processing, sensors, data acquisition and transmission, and display.
- Develop, test, and evaluate undersea surveillance systems, including towed arrays, autonomous arrays, deployable arrays, fixed distributed systems, active systems, and fiber-optic systems; act as TDA for project ARIADNE.
- Develop data processing, signal processing, and display subsystems; assess performance of undersea surveillance capabilities; predict future performance; maintain software; provide system engineering, test and evaluation, and laboratory facility support for the Integrated Undersea Surveillance System (IUSS) (Lead Laboratory).
- Develop a surveillance test and integration center at NOSC.
- Provide system engineering, software verification and validation, and test and evaluation for Relocatable Over-the-Horizon Radar (ROTHR) system.
- Develop, test, and evaluate electromagnetic (EM) surveillance systems; electronic warfare (EW)/command control and communications countermeasures (C^3CM) systems; and millimeter-wave/microwave systems, devices, and technologies.
- Develop electro-optic/infrared (EO/IR) surveillance systems and provide Fleet support.
- Provide technical support for signals warfare programs.

NOSC

MAJOR TECHNICAL PROGRAMS
(continued)

UNDERSEA WEAPON SYSTEMS

- Develop antisubmarine warfare (ASW) architecture for SPAWAR (Lead Laboratory).
- Develop and support MK 46 and MK 50 torpedoes for the Naval Sea Systems Command (NAVSEA) as TDA (Lead Laboratory).
- Act as Design Agent (DA) and provide life-cycle support for the ASW Control System (ASWCS) MK 116 (Mods 5, 6, 8, and 9); act as TDA for MK 116 (Mod 7).
- Provide engineering support for the Antisubmarine Rocket (ASROC) system (DA); support Fleet training for ASROC with the Test ASW Missile (TASWM).
- Develop the Vertical Launch ASROC (TDA).
- Develop the Fleet Operational Readiness Accuracy Check Sites (FORACS) (TDA); serve as technical advisor to NATO FORACS for NAVSEA.
- Provide real-time simulation to support development of MK 46, MK 48 Advanced Capability (ADCAP), and MK 50 torpedoes (Lead Laboratory).
- Develop technology for Underwater Combat Control for Surface Ships (UCCSS) to support over-the-horizon (OTH) and future multiplatform operations.
- Conduct R&D in support of high-efficiency cavitation-resistant propulsors and combustion and condensation mechanics for undersea vehicles.
- Operate and maintain ocean test ranges, torpedo propulsion facilities, transducer calibration facilities, and an underwater recovery vehicle.

SUBMARINE ARCTIC WARFARE (Lead Laboratory)

- Provide Navy-wide coordination for all arctic-related submarine R&D cruises.
- Provide technical support for submarine arctic warfare readiness and training of submarine forces.
- Develop the under-ice piloting sonar, diving control systems, and sensing systems.
- Provide environmental surveys and charting of arctic areas.

MARINE SCIENCES

- Develop marine biosciences and marine animal systems for performing Navy tasks (Lead Laboratory).
- Develop broadband sonar (bionic) systems.
- Support RDT&E in environmental sciences and chemistry in conjunction with Navy environmental protection, quality assessment, and installation restoration programs.
- Support RDT&E in marine science for ocean surveillance systems.
- Provide RDT&E in ocean and atmospheric sciences in support of Navy EM/EO/acoustic systems affected by the propagation environment.

NOSC

MAJOR TECHNICAL PROGRAMS
(continued)

- Provide RDT&E in advanced teleoperator technology for operations in hostile environments.
- Develop propagation assessment systems such as Integrated Refractive Effects Prediction System (IREPS), Propagation Forecasting Terminal (PROPHET), and associated Tactical Decision Aids.

OCEAN ENGINEERING

- Provide engineering and management support for the AN/SLQ-48(V) Mine Neutralization System (MNS)(TDA), including the unmanned, tethered Mine Neutralization Vehicle (MNV).
- Develop unmanned remote undersea search and work systems, including the Advanced Tethered Vehicle (ATV) and the Advanced Unmanned Search System (AUSS) (TDA).
- Develop the Multimission Autonomous Undersea Vehicle (AUV) Prototype System (MAPS) (DA).

DESIGN ENGINEERING, TESTING, AND PROTOTYPE DEVELOPMENT

- Support equipment manufacturing technology programs for novel electronic devices, materials, microwave tubes, fiber optics, weapon systems, integrated circuits, and robotics.
- Coordinate Navy-wide RDT&E program in automatic testing technology and integrated diagnostics.
- Manufacture microelectronic components no longer commercially available but needed to support Fleet systems.
- Develop shore-based automatic test equipment for TRIDENT.
- Provide system engineering and T&E support for the USMC Ground-Air Telerobotic Systems (GATERS) Program (Principal Development Activity).

ELECTRONIC SCIENCES AND TECHNOLOGY

- Research and develop sub 500-μm device (beyond very high-speed integrated circuit (VHSIC)) technology using charged-particle-beam-ion manufacturing processes.
- Develop fiber-optics technology and application to undersea systems, including unmanned vehicles.
- Develop long fiber-optic data links suitable for use in high-speed payout application areas.
- Characterize and evaluate infrared solid-state emitters, detectors, and focal plane arrays for use in high-performance military systems.
- Enhance the Navy's ability to use very large-scale integration (VLSI) and develop the technologies for high-speed processors and other essential electronics to upgrade reliability, cost effectiveness, and performance of key weapons systems.

NOSC

MAJOR TECHNICAL PROGRAMS

(continued)

- Manage Navy's exploratory development program in lasers and microelectronics.
- Conduct research on high-temperature ceramic superconductors in bulk and thin film forms including the effects of chemical modifications on the structure, transition temperature, and critical currents.
- Develop and demonstrate an architectural concept for implementing an Artificial Neural Network (ANN) with modifiable interconnections and delta-learning capability in silicon VLSI circuitry.
- Develop, apply, and transition (to industry) 100-μm device technology in complementary metal-oxide semiconductor (CMOS) and/or bipolar on thin film 100-μm silicon-on-sapphire (SOS) incorporating novel interconnect techniques.

NOSC

MAJOR ACCOMPLISHMENTS (FY 1986 & 1987)

PROGRAMS NEARING FLEET INTRODUCTION

ENHANCED VERDIN PROCESSOR. Completed OPEVAL.

FLAG DATA DISPLAY SYSTEM (FDDS). Installed major software and hardware upgrades to existing FDDS-equipped CVs. Assisted SPAWAR in the award of a contract for FDDS Increment 2+ for remaining TFCC ships.

SUPPORT TO FLEET EXERCISES. Provided support to several major exercises, including K-310 5/Phase I, PACFACT 86, and National Week 88A.

NAVY SCIENCE ASSISTANCE PROGRAM (NSAP). Developed prototypes of hardware for evaluation in Fleet exercises which include Amphibious Force Communications Link, FMFPAC; Radio Beacon, FMFLANT; Link 4A Test Set and Swimmer Delivery Vehicle (SDV) Tracker, COMNAVSURFPAC; IR Sensor and Graphics Transmission, COMTHIRDFLT.

MINE NEUTRALIZATION SYSTEM (MNS). In production. Completed first shipyard deliveries.

MINE HUNTING SYSTEM. Completed OPEVAL of MK 18 (Mod 1).

SUBMARINE ICE EXERCISE (SUBICEX). Provided planning, coordination, and technical support to highly successful submarine arctic operations.

SECURE CONFERENCING PROJECT. Provided CINC-level secure conferencing capability for eight Pacific Theater sites; 26 sites in Pacific, CONUS, and Europe will be operational by the end of the calendar year 1987.

JINTACCS/RAINFORM TRANSLATOR UNIT (JTU). Completed certification and installation of JTU systems at ten major Navy command and control systems nodes ashore and six aircraft carriers.

INTERIM C^2 SYSTEMS. Contributed systems design and installation in four battle groups to meet early deployment schedules.

ARCTIC PULSED EXPERIMENTAL ICE-AVOIDANCE SONAR (APEX). Completed development. Obtained installation approval for SSN-637-class ships. Delivered units to the Fleet.

SHIP TOWED ACOUSTIC DECEPTION DEVICE (STADD)(AN/SLQ-33). Achieved initial operational capability.

UNDERWATER FIRE CONTROL SYSTEM (UFCS) MK 116 (MOD 4). Completed delivery to CG 47 through CG 55.

INTEGRATED UNDERSEA SURVEILLANCE SYSTEM (IUSS). Initiated work on the Advanced Surveillance Work Station (ASWS) supporting the Surveillance Direction System (SDS) for Phase III of IUSS. Completed major exercise test bed of the Fixed Distributed System (FDS).

SATELLITE COMMUNICATIONS GROUND COMMAND POST TERMINAL (AN/GSC-40). Completed development and deployment for all Europe and Pacific Theater sites. These terminals provide survivable two-way communications for theatre-level commanders.

SURVEILLANCE TOWED ARRAY SENSOR SYSTEM (SURTASS). Certified the first ten SURTASS/T-AGOS systems for Fleet operational use.

30 SEPTEMBER 1987

NOSC

MAJOR ACCOMPLISHMENTS (FY 1986 & 1987)

(continued)

SIGNALS INTELLIGENCE (SIGINT) SYSTEM. Delivered for operational use.

VLF SUBMARINE COMMUNICATIONS. Developed and deployed new processors and software improving strategic communications coverage in both benign and stressed environments.

TACTICAL DEVELOPMENT AND EVALUATION (TACD&E). Completed development on RIMPAC 86 and FLEETEX Lessons Learned, Counter HF Communications TACMEMO, Battle Force/Battle Group (BF/BG) C^3 TACMEMO and proposed Naval Warfare Publications (NWP) changes, Afloat Correlation TACMEMO, OTH-T Systems Operational Concept and TACMEMO, Pacific Fleet ASW Squadron Lessons Learned, Strike Warfare Commander TACNOTE, MK 46 Air-Drop TACMEMOS, and Surface Ship Passive Targeting TACMEMO and Tactical Decision Aid.

MINIMUM ESSENTIAL EMERGENCY COMMUNICATIONS NETWORK (MEECN). Developed and deployed the tri-service MEECN Message Processing Mode (MMPM) which provides improved performance to strategic platforms in a stressed environment.

ADVANCED TETHERED VEHICLE (ATV). Completed and verified fiber-optic telemetry system design. Completed fabrication and initiated sea testing of vehicle launch/recovery equipment.

COMPUTERIZED DEPLOYMENT SYSTEM (CODES). Delivered to military traffic management command for operational use.

NAVY STANDARD DIVING BOAT. Completed OPEVAL.

ANTISUBMARINE WARFARE CONTROL SYSTEM MK 116 (MOD 5). Conducted TECHEVAL testing on DD 980.

CENTRAL IFF PROJECT. Completed critical design review.

SATNAV/OMEGA. Installed integrated SATNAV/OMEGA systems on PACFLT and LANTFLT ships.

ANTIAIR WARFARE (AAW) TACTICAL DECISION AIDS. Developed AAW Tactical Decision Aids for Tactical Environmental Support System (TESS).

TECHNOLOGICAL ACHIEVEMENTS

SUBMARINE LASER COMMUNICATIONS. Demonstrated the feasibility of optical communications with submarines through component technology development and communication channel performance experiments.

ADVANCED UNMANNED SEARCH SYSTEM (AUSS). Completed over 89 dives in deep autonomous operation.

LOW-FREQUENCY ACTIVE (LFA). Initiated development of major system components for Advanced Development Model (ADM) test and evaluation phase. Completed initial draft of operational system concept.

ARTIFICIAL INTELLIGENCE. Installed prototype Command Action Team (CAT) expert system on board an aircraft carrier.

ICEX-87. Completed Phase I of data-gathering effort in support of Arctic ASW.

NOSC

MAJOR ACCOMPLISHMENTS (FY 1986 & 1987)

(continued)

WATERFRONT MAINTENANCE MANAGEMENT SYSTEM (WMMS). Initiated development of a distributed computer system using the Defense Data Network (DDN) as the type commander's Technical Direction Agent in support of COMNAVSURFPAC maintenance programs.

ARIADNE. Completed extensive feasibility demonstration model sea tests and began advanced technology demonstration phase of deployable, lightweight, fiber-optics distributed array.

GROUND-AIR TELEROBOTICS SYSTEMS (GATERS). Developed teleoperated vehicle systems and airborne, remotely operated devices to be deployed and evaluated by the Fleet Marine Forces.

SYSTOLIC ARRAY PROCESSOR. Demonstrated the capability to support 250 million floating-point operations per second for application to adaptive beamforming and for increase of nulling capability (using eight antennas against seven jammers) with increased processing speed as required in high-frequency direction finding.

AUTOMATED POSITION TRACKING SYSTEM (APTS). Completed installation at FORACS V, Andros Island, Bahamas.

U.S. FORACS UPGRADES. Completed installation of five Radio Direction Finding Test Systems and five Electronic Warfare Support Measurement (ESM) Systems.

INDEPENDENT EXPLORATORY DEVELOPMENT (IED)/THIN FIBER. Completed development of advanced reduced-diameter single-mode optical fiber.

SMALL UNIT NAVIGATION SYSTEMS (SUNS). Completed initial designs.

MINIATURE GLOBAL POSITIONING SYSTEM (GPS) PROGRAM. Completed critical design review.

AUTOMATED ORGANOTIN ANALYZER. Developed automated analyzer for near-realtime measurement of organotin compounds in seawater at parts-per-trillion levels.

ORGANOTIN ANTIFOULING COATINGS. Completed risk assessment and baseline surveys for Fleet implementation of improved organotin antifouling coatings.

POWER FIELD-EFFECT TRANSISTOR (FET). Demonstrated stable InP (indium phosphide) power metal-insulator-semiconductor FET (MISFET). Performance parameters (power output of 4.5 W, power-per-unit gate width of 4.5 W/mm, power-added efficiency of 50% at 10 GHz) far surpass GaAs FET capabilities.

GUNN AMPLIFIER. Demonstrated triplexed wide-band InP Gunn amplifier for a range of 75 to 110 GHz, with an output power of 50 mW and gain of 15 dB.

IED/DIRECTION FINDER. Demonstrated a wide-band, frequency-independent, electro-optic direction finder using fiber optic delay lines.

INDEPENDENT RESEARCH (IR)/ULTRATHIN FILMS. Fabricated n- and p-channel devices in ultrathin ($< 1000\text{Å}$) silicon-on-sapphire (SOS) with measured mobilities comparable to state-of-the-art bulk silicon devices resulting in a major 6.2 effort to develop a new family of radiation-hard "beyond VHSIC" devices.

30 SEPTEMBER 1987

NOSC

MAJOR ACCOMPLISHMENTS (FY 1986 & 1987)

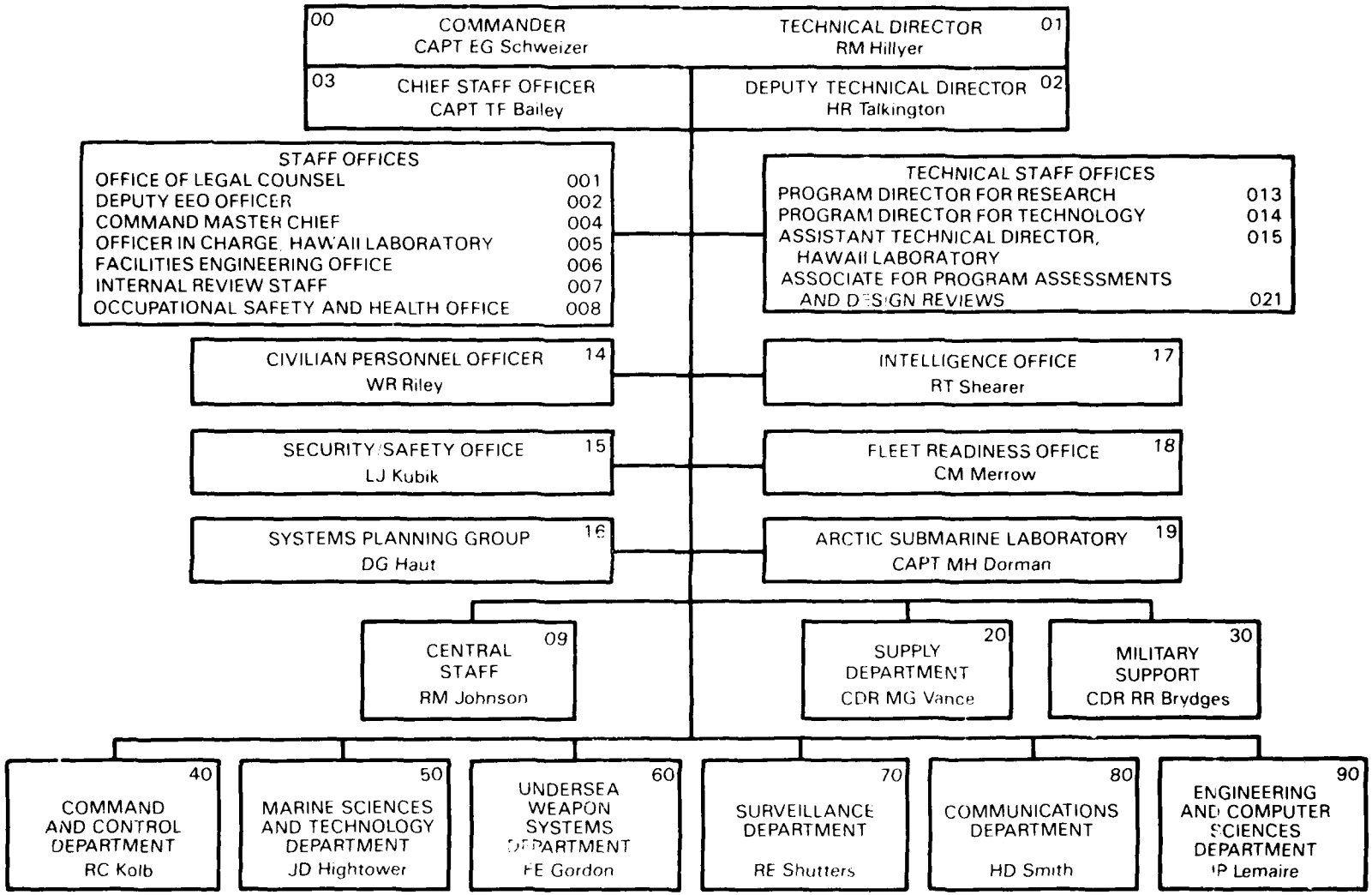
(continued)

IR/MODIFICATION OF TURBULENT BOUNDARY LAYER. Demonstrated that vinyl riblet tape reduces hydrodynamic drag by as much as 8% (±2%) in exterior flow and 25% in pipe flow.

IR/THERMAL CONDUCTIVITY MEASUREMENTS ON ANODIZED COATINGS. Identified thermal conductivity of anodized films as a limiting factor in the performance of Stored Chemical Energy Propulsion Systems (SCEPS). Developed improved films with double the thermal conductivity as a potential solution.

NOSC

NOSC ORGANIZATION



30 SEPTEMBER 1987

NOSC

PERSONNEL DATA

TOTAL ON BOARD	TOTAL MILITARY	TOTAL CIVILIANS	FTP*	TPTI**	FTP UNGRADED
3322	251	3071	3029	42	73

FTP GRADED: 2956

ADMINISTRATIVE	504
TECHNICIANS	380
SCIENTISTS AND ENGINEERS	1568
OTHER	504

FTP GRADED SCIENTISTS AND ENGINEERS

ELECTRONICS ENGINEERS	746
PHYSICISTS	225
MECHANICAL ENGINEERS	158
MATHEMATICIANS	106
GENERAL ENGINEERS	32
OCEANOGRAPHERS	23
OPERATIONS RESEARCH ANALYSTS	60
COMPUTER SCIENTISTS	114
PSYCHOLOGISTS	19
CHEMISTS	17
OTHER	68
TOTAL	1568

CIVILIAN BUDGETED END-STRENGTH:
FTP AND TPTI (COMBINED) 2995
MILITARY ALLOWANCE:
OFFICERS 61 ENLISTED 213 274

SCIENTISTS AND ENGINEERS BY DEMO PROJECT LEVEL

I	54
II	263
III	979
IV	266
SES	5

NOSC is participating in a Demonstration Project under Title VI of the 1978 Civil Service Reform Act. The pay classification system has been restructured into five levels of classification as follows: Level I: GS 5-8; Level II: GS 9-11; Level III: GS 12 and 13; Level IV: GS 14 and 15; Level V: GS 16.

DEGREES — ALL FTP PERSONNEL

	PhD	DVM	MS/MA	BS/BA
SCIENTISTS & ENGRS	184	2	539	822
OTHER CIVIL SERVICE	7	—	84	292
MILITARY OFFICERS	1	1	25	16
TOTAL	192	3	648	1130

*Full time, permanent civilian personnel
**Temporary, part time, intermittent civilian personnel subject to manage to payroll (MTP) controls.

30 SEPTEMBER 1987

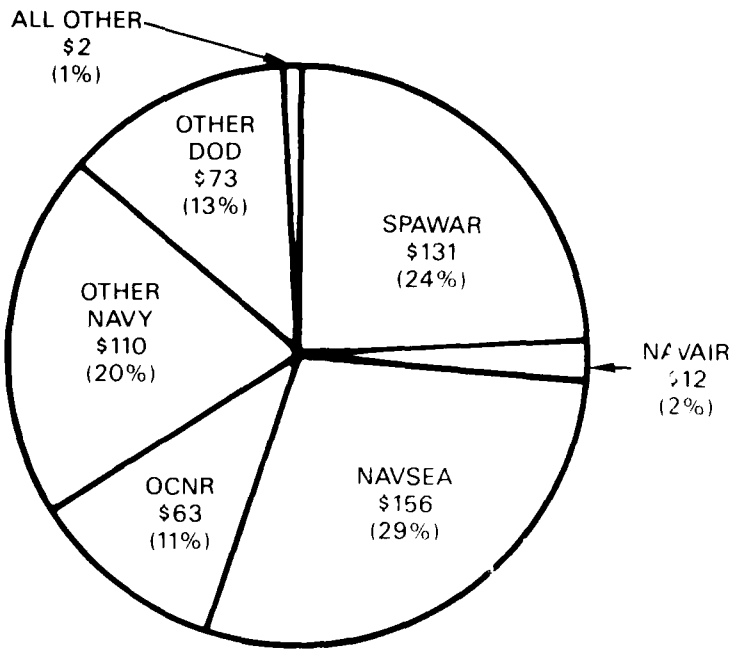
NOSC

NOR

FUNDING BY SPONSOR

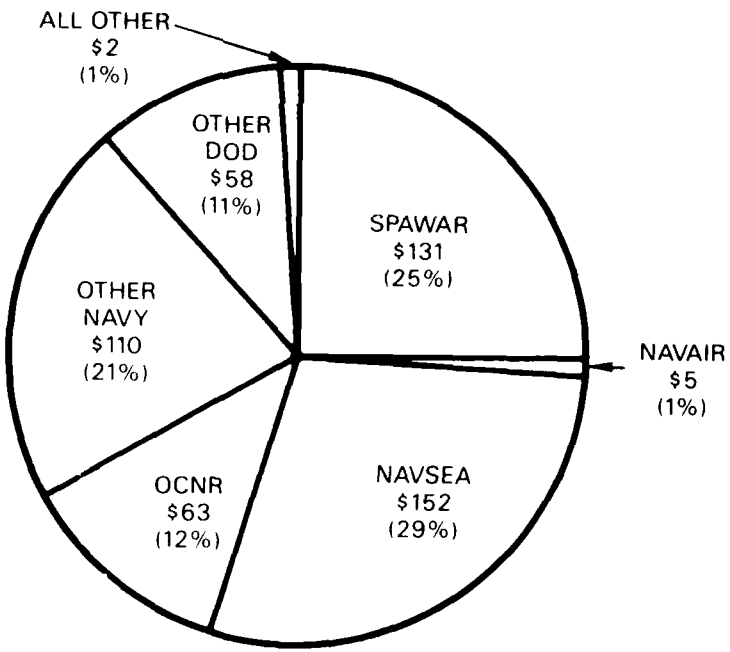
NEW ORDERS RECEIVED
($ IN MILLIONS)

FY 1987
ACTUAL $547*



*Includes Direct Cites $219 million

FY 1988
PLANNED $525**



**Includes Direct Cites $215 million

SPAWAR	SPACE AND NAVAL WARFARE SYSTEMS COMMAND
NAVAIR	NAVAL AIR SYSTEMS COMMAND
NAVSEA	NAVAL SEA SYSTEMS COMMAND
OCNR	OFFICE OF THE CHIEF OF NAVAL RESEARCH

Direct Cites — Requests for Contractual Procurement (RCPs) and Military Interdepartmental Purchase Requests (MIPRs) Financed directly by sponsor rather than NOSC NIF account

30 SEPTEMBER 1987

NOSC

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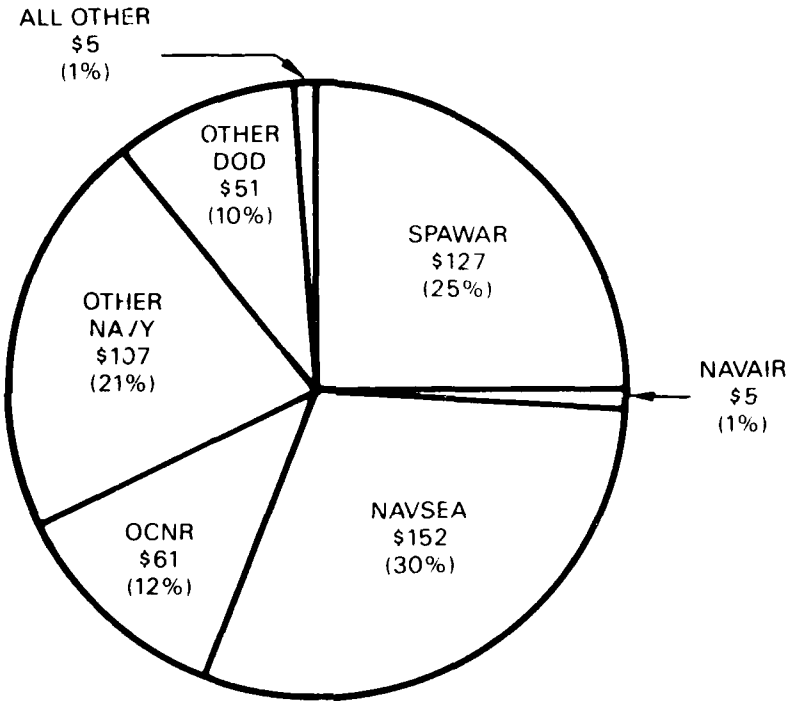
FUNDING BY SPONSOR

NEW ORDERS RECEIVED
($ IN MILLIONS)

FY 1989

PLANNED $508*



*Includes Direct Cites $200 million

SPAWAR - SPACE AND NAVAL WARFARE SYSTEMS COMMAND
NAVAIR - NAVAL AIR SYSTEMS COMMAND
NAVSEA - NAVAL SEA SYSTEMS COMMAND
OCNR - OFFICE OF THE CHIEF OF NAVAL RESEARCH

30 SEPTEMBER 1987

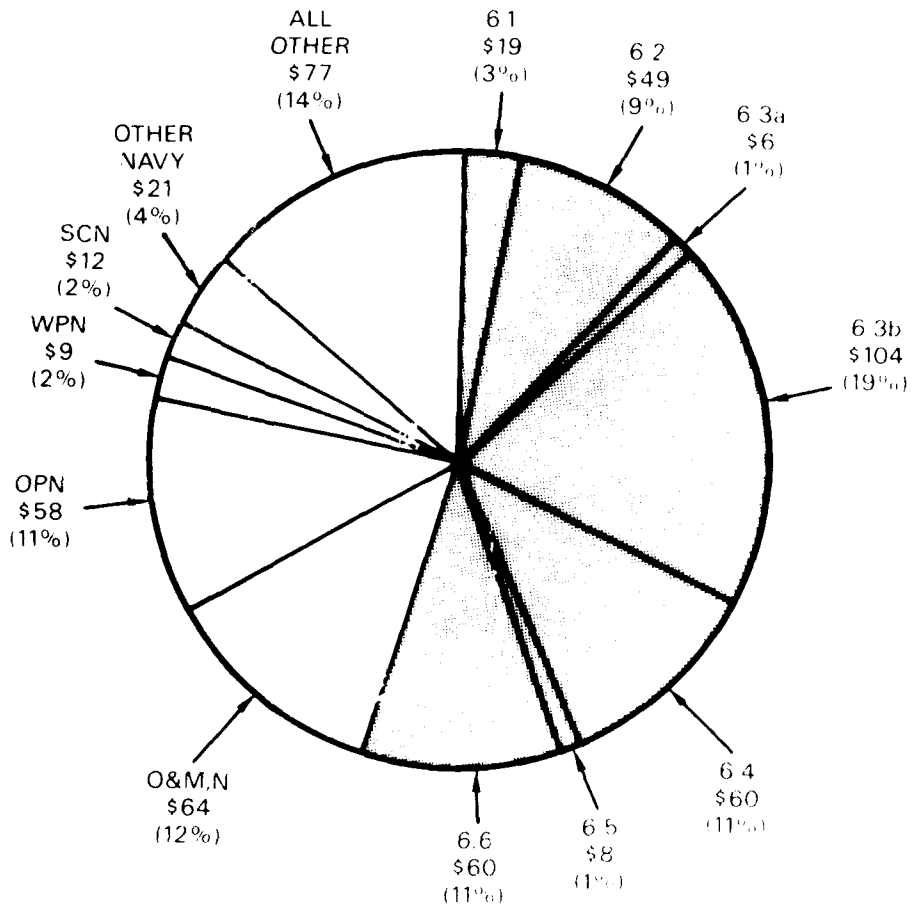
NOSC

NOR

FUNDING BY APPROPRIATION

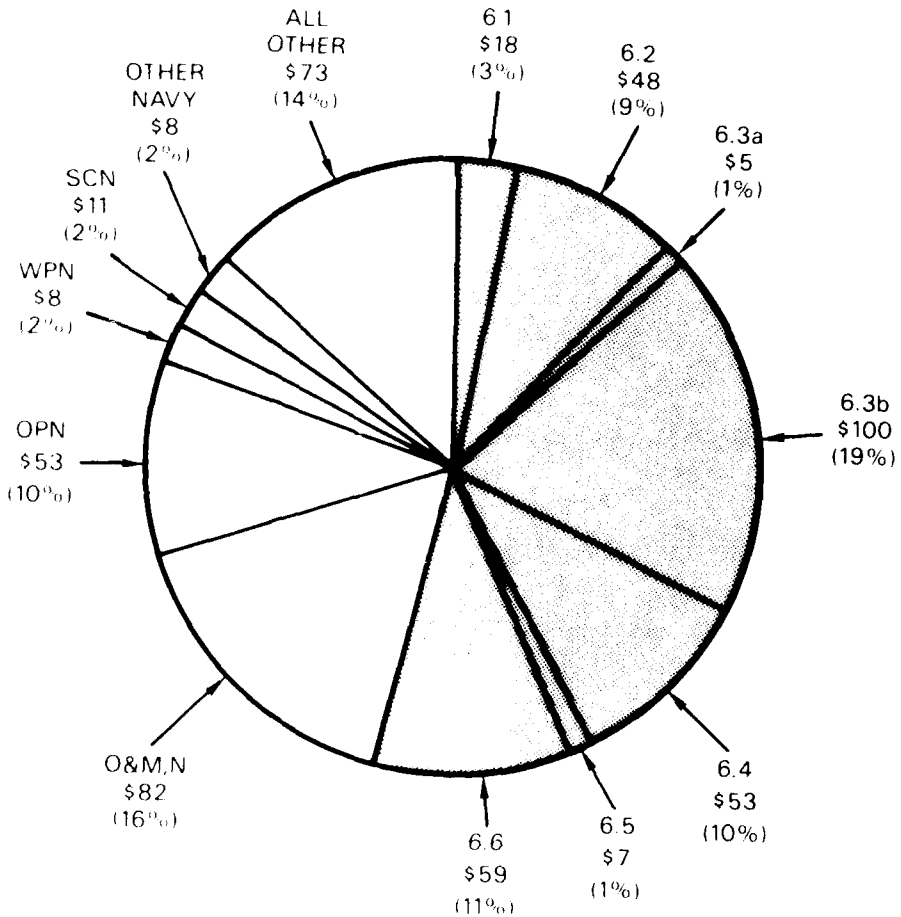
NEW ORDERS RECEIVED
($ IN MILLIONS)

FY 1987
ACTUAL $547*



*Includes Direct Cites
$219 million

FY 1988
PLANNED $525**



**Includes Direct Cites
$215 million

RDT&E FUNDS

30 SEPTEMBER 1987

NOSC

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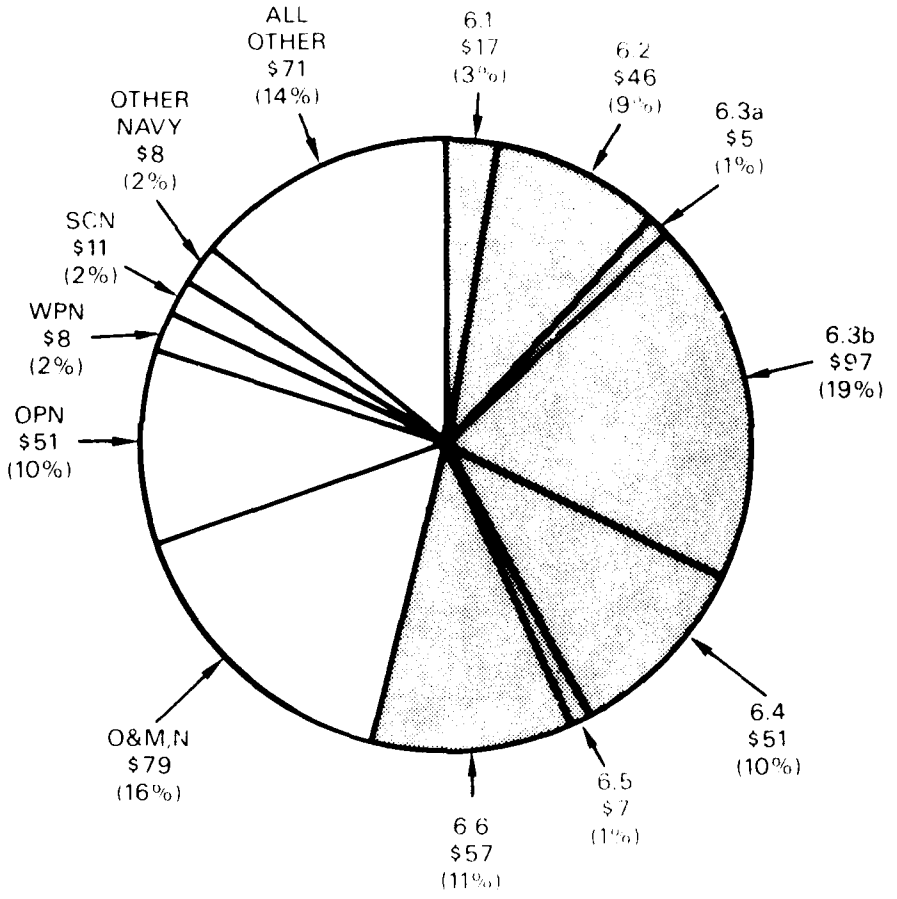
FUNDING BY APPROPRIATION

NEW ORDERS RECEIVED
($ IN MILLIONS)

FY 1989

PLANNED $508*



RDT&E FUNDS

*Includes Direct Cites $200 million

30 SEPTEMBER 1987

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FUNDS BY CATEGORY AND TYPE

NEW ORDERS RECEIVED
($ IN MILLIONS)

CATEGORIES & TYPE	FY 1987			FY 1988			FY 1989		
	$M ACTUAL	% of RDT&E	% of TOTAL	$M PLANNED	% of RDT&E	% of TOTAL	$M PLANNED	% of RDT&E	% of TOTAL
RDT&E CATEGORY									
6.1 RESEARCH	19	6	3	18	6	3	17	6	3
6.2 EXPLORATORY DEVELOPMENT	49	16	9	48	17	9	46	17	9
6.3a ADVANCED TECHNOLOGY DEVELOPMENT	6	2	1	5	2	1	5	2	1
SUBTOTAL	74	24	13	71	25	13	68	25	13
6.3b ADVANCED DEVELOPMENT	104	33	19	100	35	19	97	34	19
6.4 ENGINEERING DEVELOPMENT	60	20	11	53	18	10	51	18	10
6.5 MANAGEMENT AND SUPPORT	8	3	1	7	2	1	7	3	1
6.6 OPERATIONAL SYSTEMS DEVELOPMENT	60	20	11	59	20	11	57	20	11
SUBTOTAL	232	76	42	219	75	41	212	75	41
TOTAL RDT&E	306	100	55	290	100	54	280	100	54
(O&M,N) OPER. & MAINT., NAVY	64		12	82		16	79		16
(OPN) OTHER PROCUREMENT, NAVY	58		11	53		10	51		10
(WPN) WEAPONS PROCUREMENT, NAVY	9		2	8		2	8		2
(SCN) SHIPBUILDING & CONVER., NAVY	12		2	11		2	11		2
OTHER NAVY	21		4	8		2	8		2
ALL OTHER	77		14	73		14	71		14
OTHER APPROPRIATION SUBTOTAL	241		45	235		46	228		46
TOTAL	547		100	525		100	508		100

30 SEPTEMBER 1987

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DISTRIBUTION OF RESOURCES AMONG MAJOR AREAS OF WORK

FISCAL YEAR 1988 ESTIMATE

	DIRECT WORK YEARS	TOTAL $M
COMMAND AND CONTROL	280	$110
MARINE SCIENCES AND TECHNOLOGY	268	63
UNDERSEA WEAPON SYSTEMS	314	112
SURVEILLANCE	398	103
COMMUNICATIONS	277	82
ENGINEERING AND COMPUTER SCIENCE	94	22
FLEET READINESS	24	3
SUBMARINE ARCTIC WARFARE	34	5
MISCELLANEOUS	70	25
TOTAL	1759	$525

30 SEPTEMBER 1987

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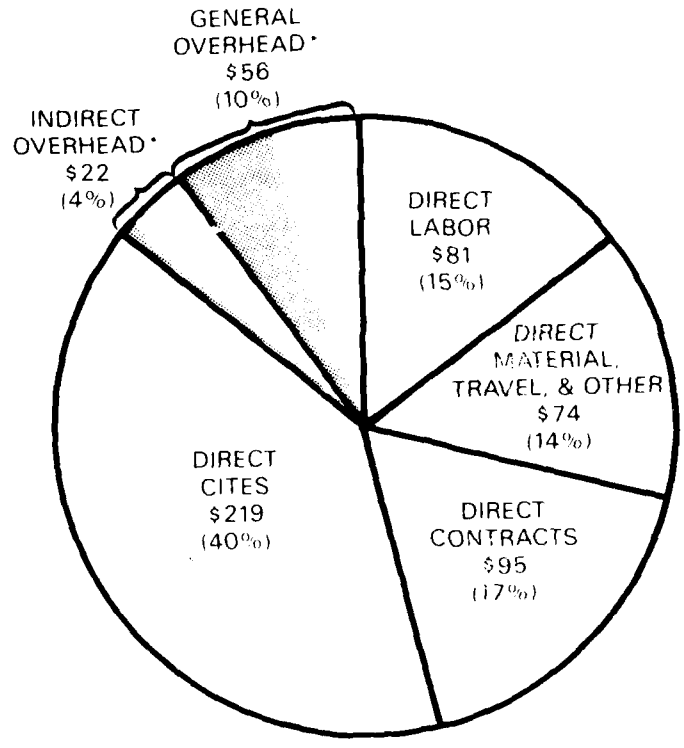
DISTRIBUTION OF FUNDS

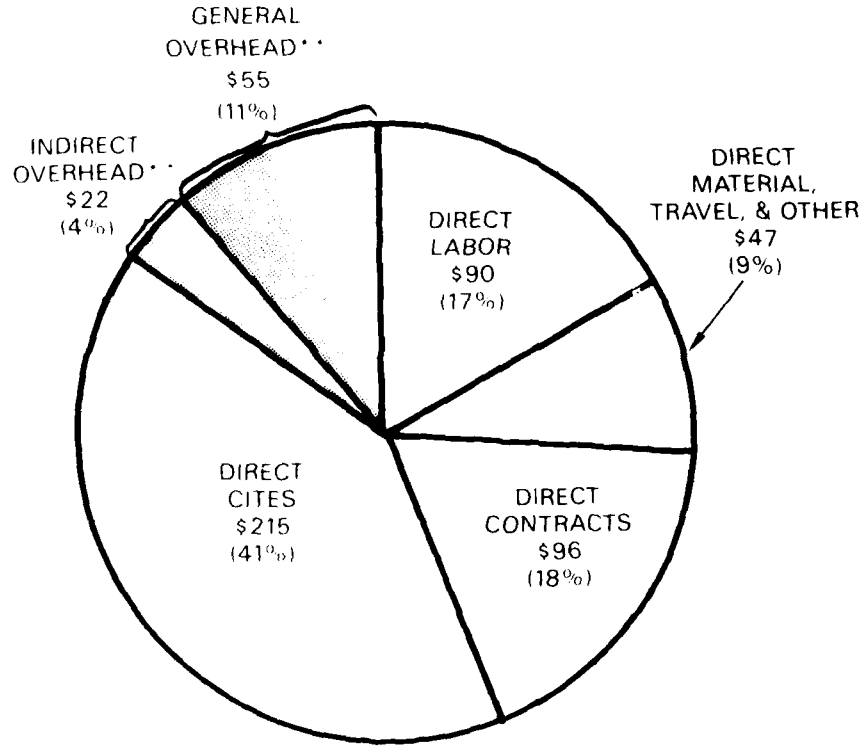
NEW ORDERS RECEIVED
($ IN MILLIONS)

FY 1987
ACTUAL $547



* CONTRACTED OUT:
INDIRECT OVERHEAD $3.7 (17%)
GENERAL OVERHEAD $28.4 (51%)

FY 1988
PLANNED $525



** CONTRACTED OUT:
INDIRECT OVERHEAD $4.4 (20%)
GENERAL OVERHEAD $28.0 (51%)

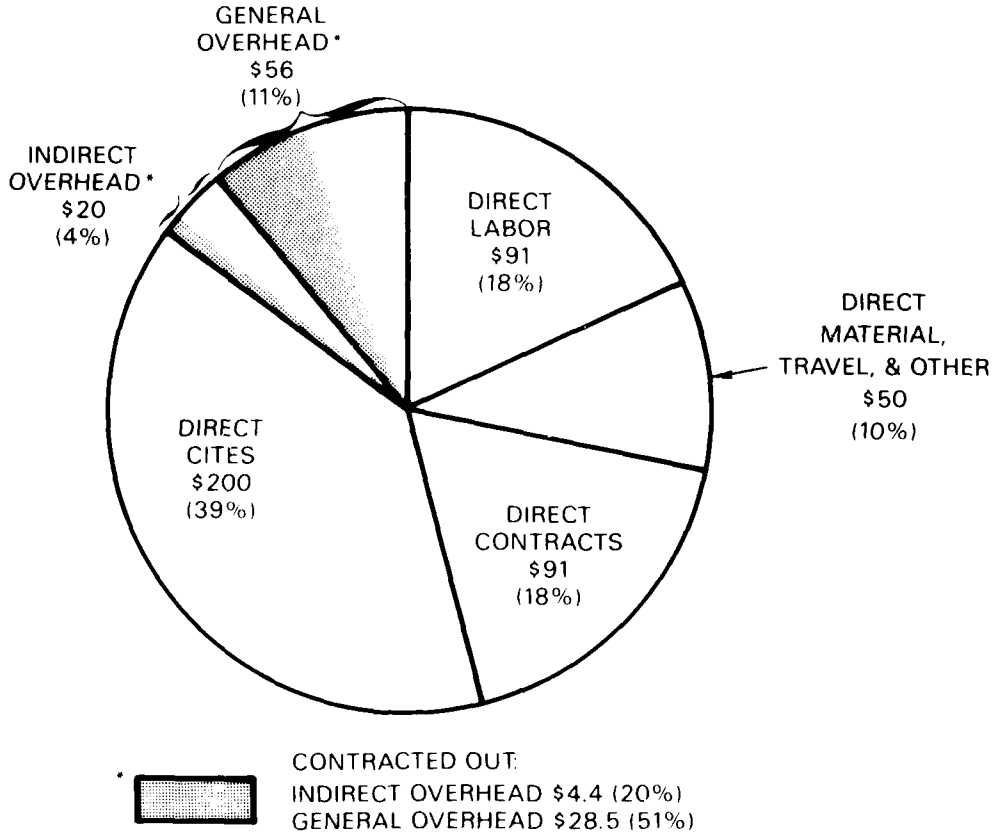
30 SEPTEMBER 1987

NOSC

DISTRIBUTION OF FUNDS

NEW ORDERS RECEIVED
($ IN MILLIONS)

FY 1989
PLANNED $508



30 SEPTEMBER 1987

NOSC

FUNCTIONS AND LEADERSHIP ASSIGNMENTS*

FUNCTIONS: As a major SPAWAR R&D Center, NOSC is primarily oriented toward research, development, and product improvement but may perform functions across the complete life cycle of a particular program or system. Major functional capabilities include basic research, exploratory development, advanced development, assessment of science and technology base, mission analysis, concept exploration and system demonstration/validation, full-scale engineering development, engineering in support of production, test and evaluation, major RDT&E facility management, user services, and support to operating forces, including product improvement.

LEADERSHIP ASSIGNMENTS: NOSC is responsible for Navy-wide leadership in the following areas:

a. Multiplatform command control and communications (C^3) systems
b. Multiplatform combat systems integration
c. Ocean surveillance (electromagnetic/electro-optic/acoustic reconnaissance and search)
d. Deep ocean engineering
e. Shipboard internal communications
f. Marine biosciences
g. Environmental description and prediction for ocean surveillance and C^3
h. Surface ship ASW fire control
i. Surface- and air-launched torpedoes

*Per NAVMAT instruction 5450.27C of 1 August 1983 (transferred to SPAWAR by OCNRNOTE 5215 of 29 April 1986)

30 SEPTEMBER 1987

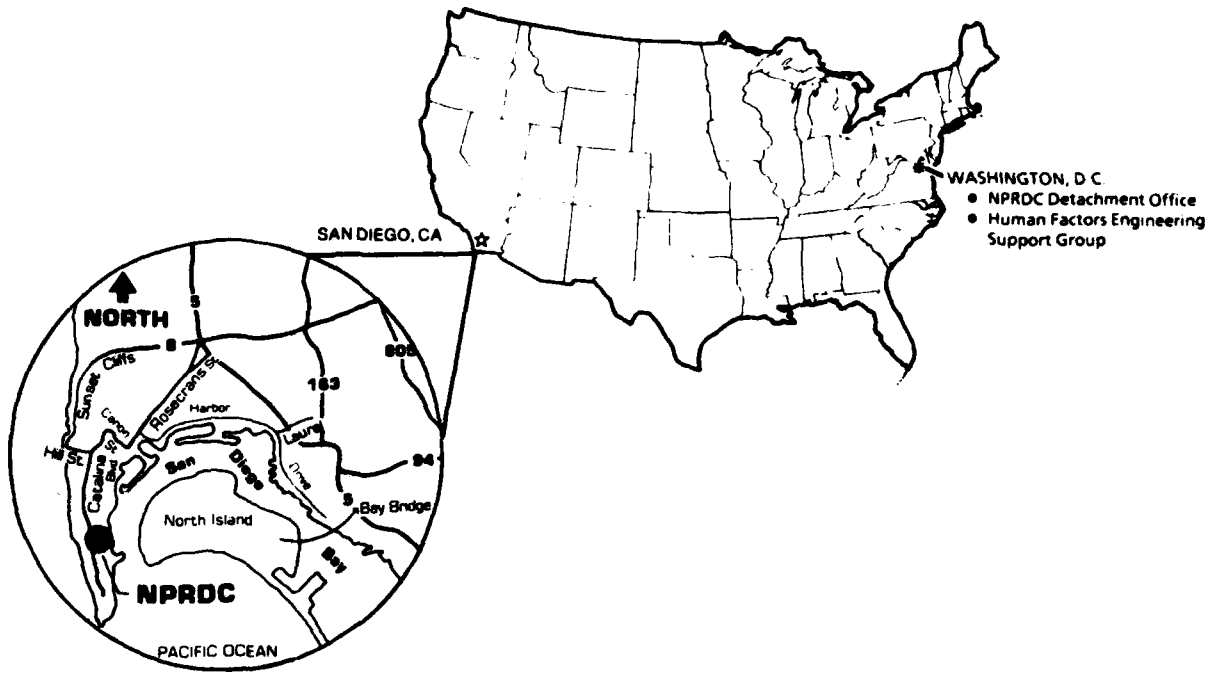
Navy Personnel Research and Development Center

San Diego, CA 30 September 1987

Brief

NPRDC

NAVY PERSONNEL RESEARCH AND DEVELOPMENT CENTER



30 SEPTEMBER 1987

NPRDC

MISSION

TO BE THE PRINCIPAL NAVY RDT&E CENTER FOR
MANPOWER, PERSONNEL, EDUCATION, TRAINING, AND HUMAN FACTORS,
AND FOR PROVIDING TECHNICAL SUPPORT TO THE
CHIEF OF NAVAL OPERATIONS IN THESE AREAS

30 SEPTEMBER 1987

NPRDC

INTRODUCTION TO THE NAVY PERSONNEL RESEARCH AND DEVELOPMENT CENTER

The Navy Personnel Research and Development Center (NPRDC) was established at San Diego on 1 May 1973. This was an initial step towards integrating the Navy's manpower and training research to improve the management, administration, selection, classification, training, performance, and retention of Navy personnel. The Center was comprised of assets from the Naval Personnel and Training Research Laboratory, San Diego; the Naval Personnel Research and Development Laboratory, Washington, DC; and the Personnel Research Division of the Bureau of Naval Personnel. All of these components were then subsequently disestablished.

To increase our responsiveness to pressing Navy needs as well as to exploit technological opportunity, NPRDC was reorganized in FY87 into six departments, each concentrating on a major area of mission function. The structure is as follows:

Departments	Product Areas	Facilities
Manpower Systems Personnel Systems Testing Systems	Manpower and Personnel	Manpower and Personnel Computing Facility
Training Technology Training Systems	Training	Training Research Computing Facility
Human Factors	Human Factors Human Resources Productivity	Systems Simulation Facility Command Systems Facility

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At the end of FY87 NPRDC's staff numbered 310 civilian employees, 182 of whom were scientists and technicians trained and qualified in areas such as psychology, education, mathematics, statistics, operations research, and economics. In addition, the staff includes 25 military personnel with extensive fleet experience. This broad base allows NPRDC to maintain a highly effective, multidisciplinary team approach to its R&D.

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FACILITIES

NPRDC is located on Point Loma in San Diego, California with support offices in Washington, DC. The Center occupies 17 buildings under a host-tenant arrangement with the Naval Ocean Systems Center.

Land area utilized: 3 acres

Buildings:

Laboratory	79,332 sq. ft.
Administration	18,417 sq. ft.
Other	0 sq. ft.

Acquisition costs:

Real property (Classes I & II)	$ .78 million
Equipment (Classes III & IV)	$ 11.8 million

In addition to office space for research and support personnel, the following research facilities are housed at the Center:

- Training Research Computing Facility--Provides general Unix-based computing services and access to the Defense Data Network (DDN) for Center research and support staff. The facility is supported by the Training Technology Department and provides computational and electronic mail support for research in the areas of artificial intelligence, computer-assisted instruction, cognitive science, testing, and training. The facility's equipment suite includes two Digital Equipment Corporation (DEC) VAX-11/780 computers and numerous peripherals.

- Manpower and Personnel Computing Facility--Provides general purpose IBM-based computing services for Center researchers and administrative operations. The facility is especially equipped to serve psychologists, economists, mathematicians, and computer scientists whose research requires the organization and analysis of large data files, the development of large-scale mathematical models, the design of

information delivery systems, and general purpose scientific computing. The facility features an IBM 4381/23, multiple tape drives, and over 25GB in disk storage.

- System Simulation Facility--Serves cognitive and organizational psychologists and human factors engineers who are concerned with the measurement of human performance, human factors in command system design, neuroscience applications in personnel readiness assessment, and motivation of people in organizations. It includes equipment for biopsychological and psychophysiological measurement

FACILITIES (con't)

- Command Systems Facility--Provides a controlled setting to examine individual and team performance in Battle Group Command environments (as well as other critical settings). Various organizational and management systems or conditions are tested in this facility, which serves social, industrial, and organizational psychologists as well as management experts.

The above facilities are supplemented by two mobile laboratories that provide R&D support at sites away from the Center, and by a large inventory of computer equipment ranging from microcomputers supporting specific projects to the Center's IBM 4341, which is used both as a stand-alone processor and as a remote job entry station.

HISTORY OF CENTER DEVELOPMENT

1 Jul 51-- The Naval Personnel Research Unit, San Diego, CA, was established under the Bureau of Naval Personnel to provide a personnel research facility close to the operating forces.

1 Jul 52-- The U.S. Naval Personnel Research Field Activity was established in Washington, DC, to provide an activity close to Navy users and systems.

26 May 61-- SECNAV Notice 5450 redesignated the two field activities as U.S. Naval Personnel Research Activities.

10 Dec 68-- OPNAV Notice 5450 redesignated the Naval Personnel Research Activity, Washington, DC, as the Naval Personnel Research and Development Laboratory due to increased emphasis on R&D.

1 Aug 69-- The Chief of Naval Operations redesignated the Naval Personnel Research Activity, San Diego, CA, as the Naval Personnel and Training Research Laboratory.

1 May 73-- The Secretary of the Navy approved the establishment of the Navy Personnel Research and Development Center (NPRDC), San Diego, CA, to provide a corporate personnel laboratory with an in-depth capability in the behavioral and management sciences. This action consolidated those research functions assigned to the Naval Personnel Research and Development Laboratory, the Naval Personnel and Training Research Laboratory, and the Personnel Research Division of BUPERS.

17 May 75-- OPNAV Notice 5450 changed command and support responsibility for NPRDC from the Chief of Naval Personnel to the Chief of Naval Material (CNM).

22 May 80-- NAVMATINST 5450.27B modified the mission statement to include Technical and Consultant Support and Services to CNO in the design, development, and operation of the Navy personnel system.

1 Oct 80-- The Commanding Officer, NPRDC directed to report for additional duty to DCNO (Manpower, Personnel & Training) (OP-01).

6 May 85-- The disestablishment of CNM changed command and support responsibility for NPRDC from CNM to Chief of Naval Research (CNR).

24 Feb 86-- The Secretary of the Navy changed command and support responsibility for NPRDC from CNR to Space and Naval Warfare Systems Command (SPAWAR).

PROGRAM WORK

NPRDC executes a core program of research and develops products that affect every Navy and Marine Corps mission that has human performance as a component. The Manpower/Personnel/Testing Systems Departments focus on designing and developing methods to enable the Navy to obtain the most appropriate qualitative and quantitative mix of personnel to meet force requirements and to employ these personnel to achieve maximum military performance and readiness. The Training /Technology/Systems Departments continuously examine and refine the Navy's training methods and apply this technology to ensure the readiness of Navy and Marine Corps personnel. Efforts in the Human Factors Department are directed at advancing the behavioral technologies for improving man's interaction's with other people and with complex hardware systems. It considers social, technical, and physical environmental factors that may enhance job performance and the quality of working life.

NPRDC's research addresses six general program areas that contribute to the day-to-day operation of the Navy:

PROGRAM AREA	FUNCTION	MISSION AREA
Manpower Systems	The Manpower Systems Department concentrates on several R&D thrusts: (1) estimating the level of military and civilian support manpower needed to keep alternative fleet configurations in a state of readiness; (2) designing systems for optimal person-job match based on cost, fleet requirements, individual preferences, and a variety of assignment policies; (3) developing large scale systems for managing the flow of personnel (accessions, retention, promotion) to attain desired skill inventories within constraints of cost and feasibility; and (4) forecasting the cost implications of alternative manpower programs and the personnel effects of different compensation initiatives.	Manpower
Personnel Systems	The R&D conducted by this department focuses on the following major thrusts: (1) improving recruiting procedures and strategies to maintain the appropriate quality and quantity of Navy military accessions, (2) predicting military performance and retention and establishing standards for school and occupation entry, and (3) analyzing and developing policies and procedures to improve the utilization and satisfaction of Navy personnel throughout their careers.	Personnel

PROGRAM WORK (con't)

PROGRAM AREA	FUNCTION	MISSION AREA
Testing Systems	The R&D conducted by this department focuses on development and evaluation of a computerized adaptive testing (CAT) version of the Armed Services Vocational Aptitude Battery (ASVAB) for personnel selection and classification. The main thrust of this research is organized around two areas: (1) psychometric research, and (2) delivery system development. Work in the psychometric area includes: development and calibration of large banks of test items; evaluation of alternative procedures for administering, scoring, and terminating adaptive tests; and demonstration of an experimental version of CAT-ASVAB. Accomplishments on the delivery system include specification of the functional requirements, evaluation of alternative generic computer hardware designs, selection of a microcomputer system, and the initiation of software development.	Personnel
Training Technology	The overall goal of this department is to develop and test training technologies that will increase the effectiveness of Navy training, while controlling its costs. This is achieved through the following R&D thrusts: (1) developmental investigations and test and evaluation of emerging technologies that have promise for the near, mid, and distant timeframes; (2) investigations of mental functioning underlying training procedures that promote efficient recall, improve problem-solving and decision making, and provide a basis for knowledge engineering and intelligent systems; (3) application of management science techniques (e.g., econometrics and operations research) to the development of models to optimize resource allocation, to test policy options, and to aid the day-to-day management of the training enterprise; and (4) short term R&D that is responsive to specific requirements of warfare area sponsors, ordinarily through the use of mature technologies.	Training

PROGRAM WORK (con't)

PROGRAM AREA	FUNCTION	MISSION AREA
Training Systems	The overall goal of this department is to employ existing and emerging technologies in the development and application of training systems to alleviate Navy training problems and improve the Navy's operational readiness. The department's major R&D thrusts are: (1) development and coordinated application of troubleshooting strategies and computer/simulation technologies to improve Navy maintenance training, (2) solving operational training problems through the modification and application of emergent systems with proven capabilities, (3) adapting and transferring military training technology to improve the effectiveness and efficiency of Navy professional and management training; (4) development of Navy training systems that will best meet the Navy's needs for skilled personnel while enabling officers and enlisted personnel to achieve their personal career goals; (5) design, delivery, and management of training to ensure maximum readiness of Navy and Marine Corps combat forces, and (6) assessing the technical and operational feasibility of emergent training programs and systems.	Training
Human Factors	The Human Factors Department conducts R&D to better understand the human and organizational processes that underlie the performance of military and civilian Navy personnel in organizational contexts and human functioning at the human-machine interface. The resulting principles and techniques are applied within an organizational systems approach to enhance motivation and productivity and to optimize the design, development, operation, and maintenance of Navy human-machine systems. The department's major R&D thrusts within the human resources productivity area include: (1) identifying and developing techniques to improve quality and quantity of productivity by individuals and organizations, (2) investigating the management	Human Factors

PROGRAM WORK (con't)

PROGRAM AREA	FUNCTION	MISSION AREA
Human Factors	factors and policies that facilitate or inhibit the functioning of Navy organizations, and (3) examining the impact of new technology on workers and organizations and determining how to realize expected benefits from the implementation of new technology. The remaining thrusts that form the man-machine systems area: (1) developing principles and techniques for evaluating and enhancing command effectiveness; (2) providing human factors support for the development of new command and control systems; (3) providing RDT&E to augment and stimulate human factors efforts in the design and development of new systems, and determining the manning, training, and supportability implications of proposed systems; (4) improving the effectiveness of individuals and teams by application of the principles of human performance; (5) ensuring the application of human factors principles and data to Navy systems throughout their life cycle; and (6) applying mathematical models to enhance decision-making capabilities of advanced combat systems.	Human Factors

In addition, NPRDC has set up a Fleet Liaison Office (FLO) to maintain liaison with staffs of Fleet, Type, and Systems Commanders for R&D support, to evaluate R&D plans and products for Fleet application and to participate in the Navy Science Assistance Program (NSAP). The FLO and NSAP also acts as a sounding board for a network of interactions and interrelationships between the operating forces of the Navy and NPRDC's technical community.

ACCOMPLISHMENTS

CLASSROOM INSTRUCTIONAL TECHNOLOGIES

The Navy does not have a systematic methodology for assuring instructional quality. A recent survey of over 100 Navy classrooms revealed significant problems with course objectives and test items, instructional standards, amount of practice, and the achievement of learning goals. The Course Evaluation System was developed to give course managers and instructors, and Navy instructional developers, the capability to pinpoint problems in ineffective courses and to make effective revisions. The Course Evaluation System will result in more efficient and effective training. The specific quantitative impact is difficult to estimate because it is not known how many Navy courses have serious problems; however, based on the survey mentioned previously, there is significant room for improvement. If it is conservatively assumed that 10 percent of Navy courses have problems and that the Course Evaluation System could effect a 10 percent increase in course efficiency as defined in man-years, then it has the potential to save between $16 and $20 million annually. A 10 percent increase is conservative because one early application of the system resulted in reducing 3 weeks of classroom training to 3 days. The Course Evaluation System integrates a great deal of empirically-based research on effective teaching and instructional development. Furthermore, it is presented in a format that allows users to systematically evaluate their instructional development, using a series of forms. When problems are detected, the system provides prescriptive guides for corrections. It is similar to the Department of Education's "What Works" pamphlet, but it goes beyond that document in scope and applicability.

ENLISTED PERSONNEL ALLOCATION AND NOMINATION SYSTEM (EPANS)

A computer-assisted system for enlisted personnel assignment is being developed. This system will improve the effectiveness of enlisted assignment through the application of large-scale, optimization models. The system will match people to jobs in accordance with multiple criteria, including fleet balance, PCS cost minimization, and individual geographic location preference. An Enlisted Personnel Allocation and Nomination System (EPANS) has been developed for non-rated personnel (Seaman (SN), Airman (AN), and Fireman (FN) apprentices). The EPANS approach was expanded to handle the assignment of Administrative/Deck/Supply ratings at the Naval Military Personnel Command. Models for these ratings were also implemented for test and evaluation. Measures of success include faster and less labor-intensive personnel actions, better decisions in terms of optimizing fiscal resources, the ability to maximize assignments to priority jobs, and the ability to maximize individual location preferences. The assignments made using the computer model, have been found to be superior to assignments made manually, in terms of speed and quality. Errors made by detailers using the manual system have been eliminated and what took days to accomplish by the manual method is accomplished in a matter of minutes with the automated system. In a test comparison with manual assignments of 386 nonrated personnel, EPANS satisfied 90 percent more first location preferences for the individual being assigned, with fleet readiness and the PCS budget being held constant. Future plans call for the development of an expanded version of EPANS for assignments that require extensive en route training.

ACCOMPLISHMENTS (con't)

SELECTION AND CLASSIFICATION

Periodically, the military services experience attrition among first-term enlistees at what are judged to be excessive rates. Each service has attempted to control or reduce such attrition using a variety of approaches, including improved screening and selection procedures. In this regard, the services have conducted an investigation of self-report background or biographic information to improve screening by identifying applicants who are most likely to have difficulty dealing with military life. NPRDC's work in this area resulted in the development and validation of a biodata questionnaire, the Recruit Background Questionnaire (RBQ), which showed value in predicting losses among both Navy and Marine Corps first-term enlistees. A 1982 General Accounting Office study suggested the RBQ as an appropriate point at which to start development of a single instrument that could be used by all services. Subsequently, NPRDC was tasked by the Office of the Assistant Secretary of Defense (Force Management and Personnel) to be the lead laboratory in developing such an instrument. The global objective of this project is to improve enlisted screening by differentiating applicants in terms of their adaptability to military service. Adaptability is defined in terms of completion of initial term of service. The specific objectives are: (1) develop a biodata questionnaire that can be used by all services, (2) validate the instrument against attrition criteria, and (3) compare it to existing instruments and procedures. A biodata questionnaire, suitable for use by all services, was developed. Two experimental versions of the questionnaire, the Armed Services Applicant Profile (ASAP), were constructed and administered to nearly 200,000 applicants for enlistment. Applicant test data has been matched against accession records to identify applicants who enlisted. Additional research has been undertaken to explore the problem of applicants' faking or distoring their answers to ASAP items. ASAP items have been administered to Navy recruits to identify instructional sets that inhibit faking. Application of distortion scales indicate that military applicants respond to biodata questions with only a small degree of "distortion to look good." In FY87, 56,675 active military accessions from the ASAP applicant cohort were tracked through their first year of service. ASAP item responses were compared between first year attrites and non-attrites in order to develop a scoring key. Incremental validity of the ASAP score was demonstrated in relation to existing military selection standards (AFQT and educational status). Cost savings estimate for the Navy is in terms of millions of dollars per year.

ACCOMPLISHMENTS (con't)

MINEHUNTING SONAR

Baseline human engineering requirements for the AN/SQQ-32 were established and procedures developed for operating the AN/SQQ-32 minehunting sonar in the ship environment. These procedures: (1) tell the operator how to adjust the sonar controls to maximize the visiblity of mine-like targets on the sonar display, (2) identify the clues, which the operators must use to detect targets and to discriminate mines from non-mines, and (3) instruct the operator in the procedures to follow from the initial detection to the final disposition of a mine. Training required to develop proficient operators was identified and published in the form of a set of training specifications. Operating procedures developed for the AN/SQQ-32 sonar will be used to train the personnel who will operate the sonar during technical evaluation (TECHEVAL) and operational evaluation (OPEVAL). Following OPEVAL the procedures will be used as the basis for fleet operation of the AN/SQQ-32 sonar.

BATTLE GROUP INFORMATION DATA BASE SYSTEM

A Battle Group Information Data Base System (BIDS) was developed to describe in detail the tasks performed by each of the Warfare Commanders. BIDS was originally developed to provide design requirements for Warfare Commanders' workstations; however, it was found to have potential for wide application. Consequently, the utility and operation of the system were briefed to many operational and headquarters commands. BIDS has been installed at Tactical Training Group, Pacific and Tactical Training Group, Atlantic for use in developing and implementing Warfare Commanders' curricula. BIDS is also being used by SPAWAR to define required operational functions (ROFs) to support warfare system architecture development, and CNET is using the list of Tactical Action Officer (TAO) functions in BIDS in developing a TAO trainer.

AUTHORING INSTRUCTIONAL MATERIALS (AIM)

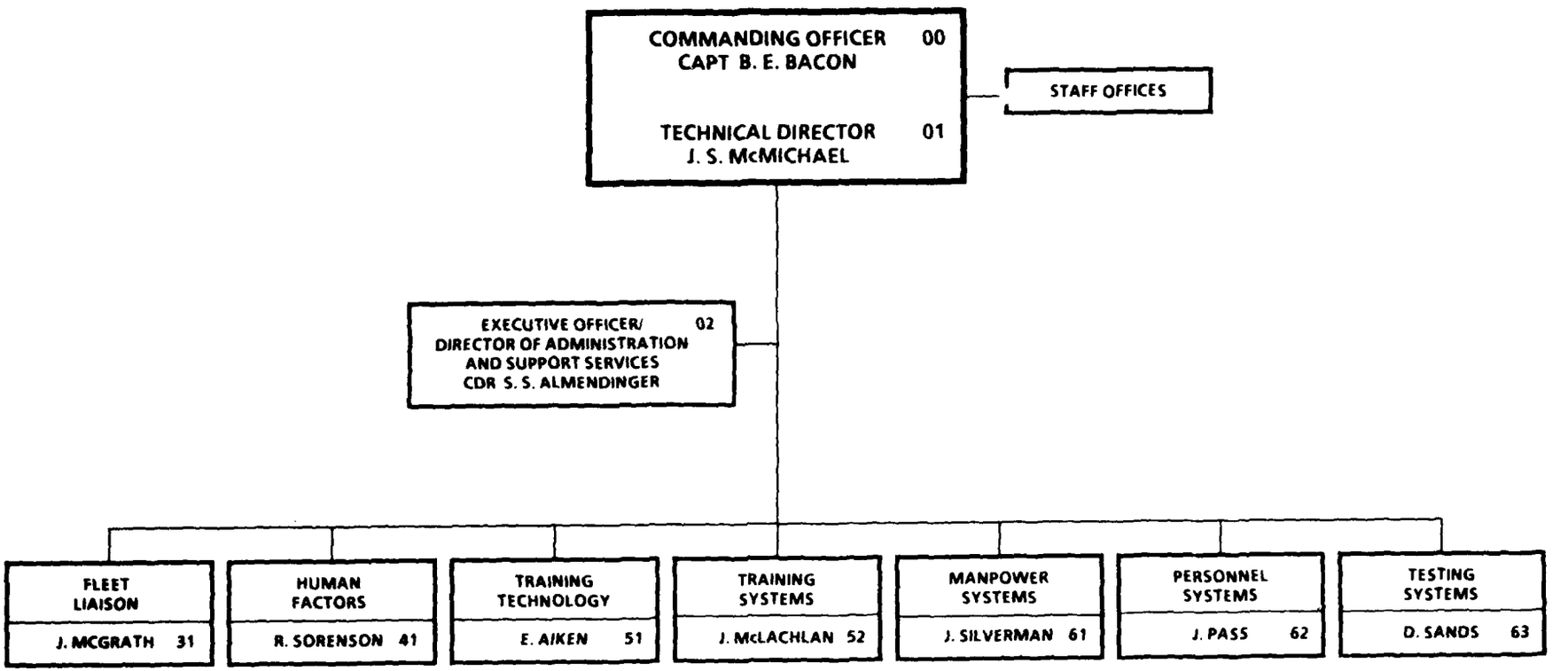
The AIM project is a series of automated systems intended to support military instructional development by providing computer-based tools that reduce the time, effort, and expertise needed to produce high quality instructional materials. The Navy teaches over 4000 different courses that require maintenance and revision. In addition, new equipment increases development and revision requirements. Attention in this effort is given to aids for developing printed materials, conventional lecture-based, computer-based or computer-delivered instruction, and videotape or videodisk instruction. Currently, the production of 1 hour of instruction requires from 100 to 1000 man-hours of effort by highly experienced personnel, at a cost of $5,000 to $50,000. As personnel costs increase and as technological advances necessitate new, increased, and more sophisticated training, the Navy's ability to meet its instructional material needs will be seriously affected by continuing budget restrictions. The intent of this project is to provide these tools to Navy instructors to make them self-sufficient and improve the efficiency of the instructional development process. The overall

ACCOMPLISHMENTS (con't)

AUTHORING INSTRUCTIONAL MATERIALS (AIM) (con't)

goal is to optimize the process of instructional development and to standardize its products. Currently, the AIM project is using a "testbed" approach to R&D; that is, the systems are being developed at user facilities to meet their needs. Testbeds are in place at the Engineering Systems Schools, Service Schools Command, Naval Training Center (NTC), Great Lakes; at Naval Education and Training Support Center, Pacific; and at Fleet Training Center, San Diego. Other testbeds will be added in early FY88 at Trident Training Facility, Kings Bay and Naval Submarine School, New London. In FY87, each of the test sites were expanded to allow the AIM system to be under "test and evaluation" use by some 150 courses at Great Lakes, NTC, and by some 140 courses at the San Diego test sites; a software support contract for the development of the general automated authoring system will be let; and graphics production was evaluated. At the AIM project test sites, the Navy standard microcomputer (the Zenith Z-248) and the contract-enhanced software will be integrated into a total system for text and graphics production and ways of managing the data base of curriculum materials, including drawings that will be developed.

NPRDC



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NPRDC PERSONNEL

FY87 End-strength

TOTAL On Board	TOTAL Military	TOTAL Civilian	FTP[1]	TPTI[2]	FTP[1] Ungraded	FTP[1] Graded
335	25	310	272	38	1	271

Authorization/Budgeted End-strength

Personnel:	FY88	FY89
Officer	6	6
Enlisted	18	16
Civilian	302	301
TOTAL	326	323

FTP[1] Graded:

Scientists	174
Administrative	54
Technicians	8
Others	36

Military:	On Board	Authorization
Officer	7	7
Enlisted	18	18
TOTAL	25	25

[1] Full-time permanent

[2] Temporary, part-time, intermittent which are subject to ceiling

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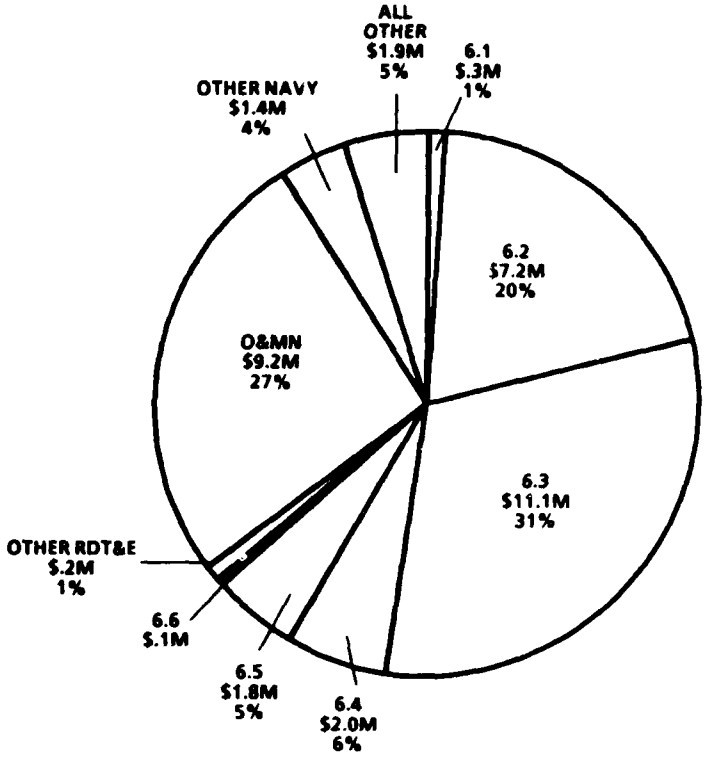
NPRDC

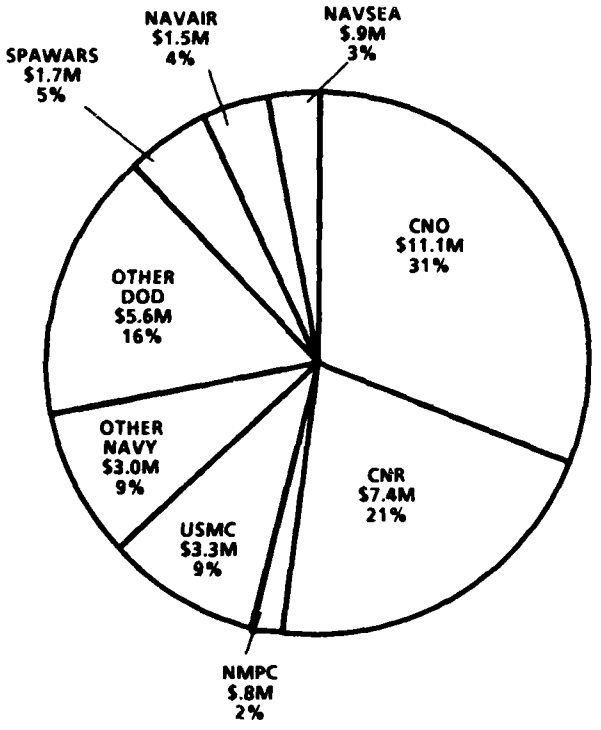
FY 1987 FUNDS – ACTUAL $35.312M

NEW OBLIGATIONAL AUTHORITY (NOA)
($ IN MILLIONS)



FUNDING BY APPROPRIATION

6.1	–	Research
6.2	–	Exploratory Development
6.3	–	Advanced Development
6.4	–	Engineering Development
6.5	–	Management and Support
6.6	–	Operational Systems Development
O&MN	–	Operation and Maintenance, Navy



FUNDING BY SPONSOR

CNO	–	Chief of Naval Operations
CNR	–	Chief of Naval Research
NAVAIR	–	Naval Air Systems Command
NAVSEA	–	Naval Sea Systems Command
NMPC	–	Naval Military Personnel Command
SPAWARS	–	Space and Naval Warfare Systems Command
USMC	–	Marine Corps

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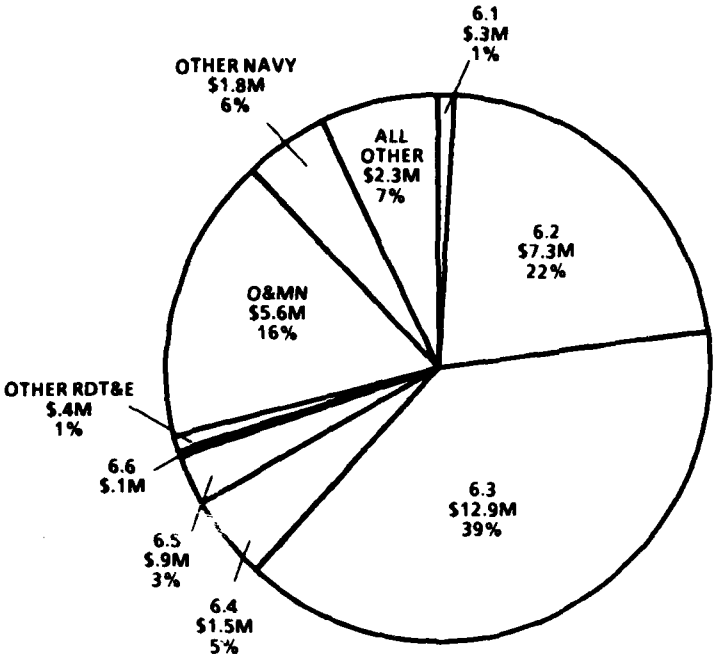
NPRDC

FY 1988 FUNDS – ESTIMATED $33.194M

NEW OBLIGATIONAL AUTHORITY (NOA) ($ IN MILLIONS)



FUNDING BY APPROPRIATION

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6.3	–	Advanced Development
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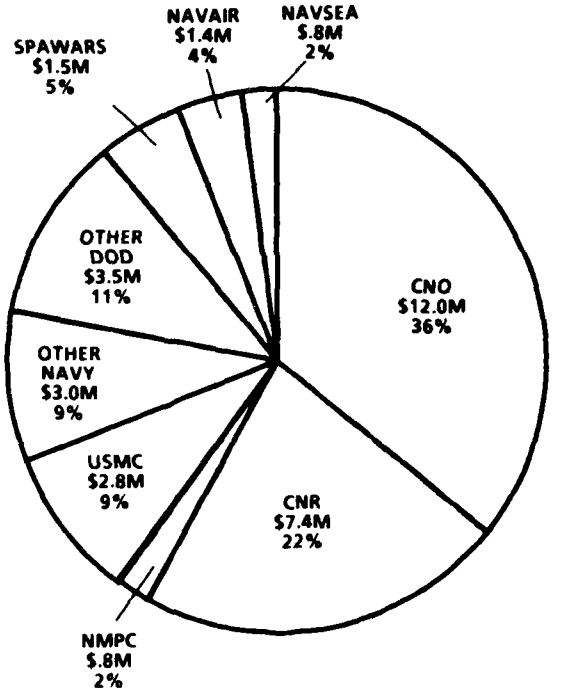
6.6	–	Operational Systems Development
O&MN	–	Operation and Maintenance, Navy



FUNDING BY SPONSOR

CNO	–	Chief of Naval Operations
CNR	–	Chief of Naval Research
NAVAIR	–	Naval Air Systems Command
NAVSEA	–	Naval Sea Systems Command
NMPC	–	Naval Military Personnel Command
SPAWARS	–	Space and Naval Warfare Systems Command
USMC	–	Marine Corps

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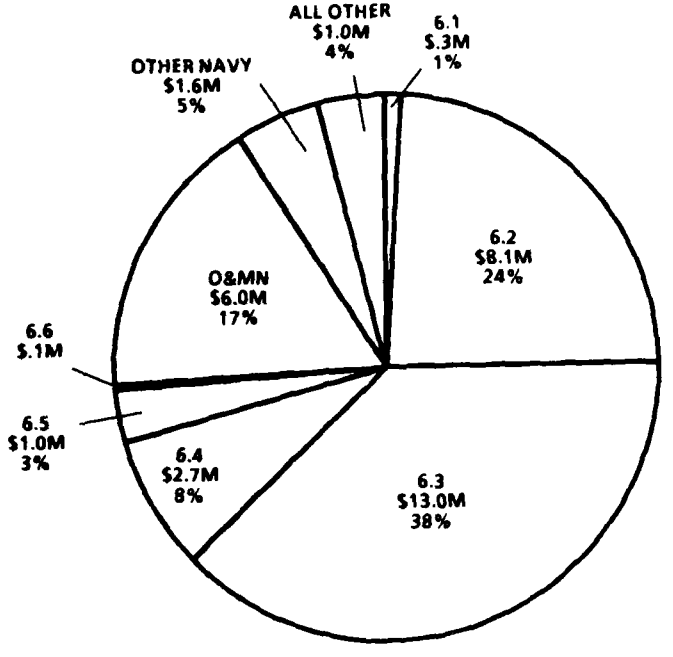
NPRDC

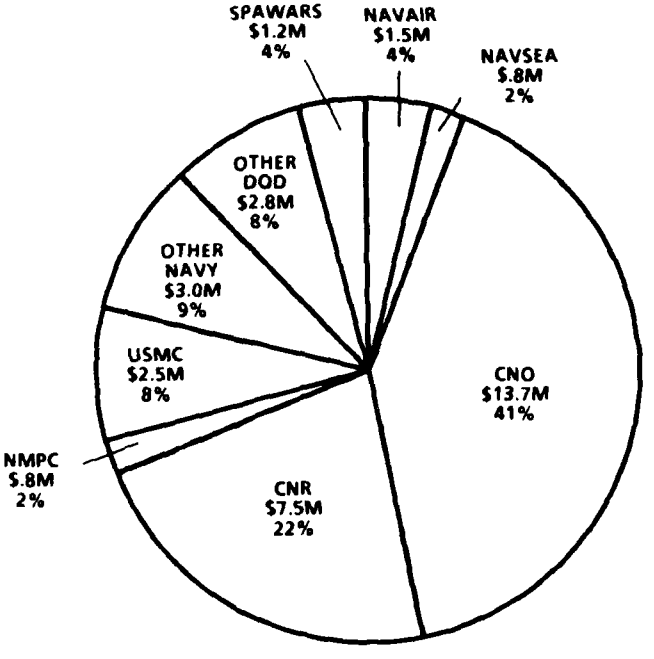
FY 1989 FUNDS – ESTIMATED $33.813M

NEW OBLIGATIONAL AUTHORITY (NOA)
($ IN MILLIONS)



FUNDING BY APPROPRIATION

6.1	–	Research
6.2	–	Exploratory Development
6.3	–	Advanced Development
6.4	–	Engineering Development
6.5	–	Management and Support
6.6	–	Operational Systems Development
O&MN	–	Operation and Maintenance, Navy



FUNDING BY SPONSOR

CNO	–	Chief of Naval Operations
CNR	–	Chief of Naval Research
NAVAIR	–	Naval Air Systems Command
NAVSEA	–	Naval Sea Systems Command
NMPC	–	Naval Military Personnel Command
SPAWARS	–	Space and Naval Warfare Systems Command
USMC	–	Marine Corps

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NPRDC

NEW OBLIGATIONAL AUTHORITY (NOA) ($ IN MILLIONS)

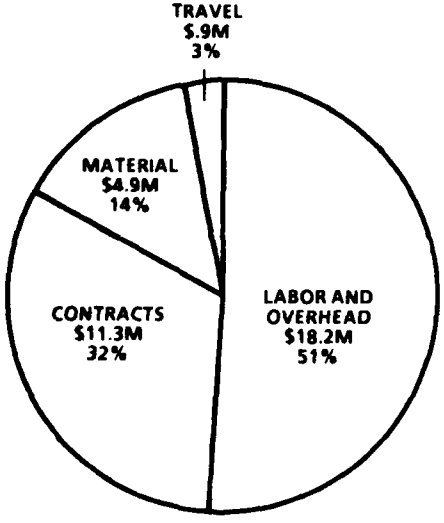
FUNDS BY CATEGORY AND TYPE

CATEGORY AND TYPE	FY1987			FY 1988			FY 1989		
	$M ACT.	% OF RDT&E	% OF TOTAL	$M EST.	% OF RDT&E	% OF TOTAL	$M EST.	% OF RDT&E	% OF TOTAL
RDT&E,N:									
6.1 RESEARCH	.312	1	1	.343	1	1	.350	1	1
6.2 EXPLORATORY DEVELOPMENT	7.211	32	20	7.298	31	22	8.063	32	24
6.3a ADVANCED TECHNOLOGY DEVELOPMENT	10.171	45	28	11.880	51	36	12.000	48	35
SUBTOTAL	17.694	78	49	19.521	83	59	20.413	81	60
6.3b ADVANCED DEVELOPMENT	.950	4	3	1.000	4	3	1.000	4	3
6.4 ENGINEERING DEVELOPMENT	2.049	9	6	1.500	6	5	2.700	11	8
6.5 MANAGEMENT AND SUPPORT	1.793	8	5	.900	4	3	1.000	4	3
6.6 OPERATIONAL SYSTEMS DEVELOPMENT	.112	0	0	.100	0	0	.100	0	0
RDT&E,N SUBTOTAL	22.598	99	63	23.021	97	70	25.213	100	74
OTHER RDT&E	.205	1	1	.392	3	1	0	0	0
TOTAL RDT&E	22.803	100	64	23.413	100	71	25.213	100	74
OTHER APPROPRIATIONS:									
(O&MN) OPERATION & MAINTENANCE, NAVY	9.193	–	27	5.640	–	16	6.000	–	17
OTHER NAVY	1.415	–	4	1.841	–	6	1.600	–	5
ARMY	.856	–	2	1.200	–	4	.200	–	1
AIR FORCE	.038	–	0	.100	–	0	.200	–	1
OTHER DOD	1.007	–	3	1.000	–	3	.600	–	2
APPROPRIATION SUBTOTAL	12.509	–	36	9.781	–	29	8.600	–	26
TOTAL	35.312	–	100	33.194	–	100	33.813	–	100

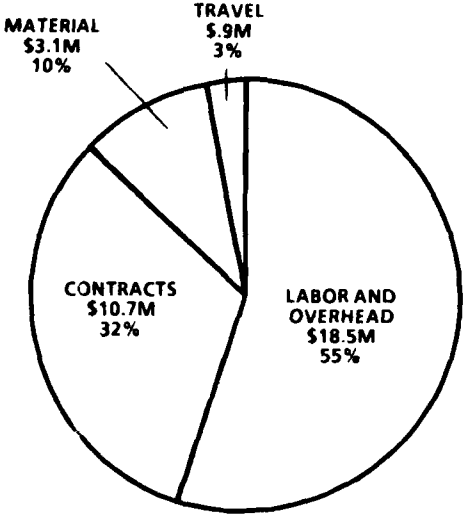
30 SEPTEMBER 1987

NPRDC

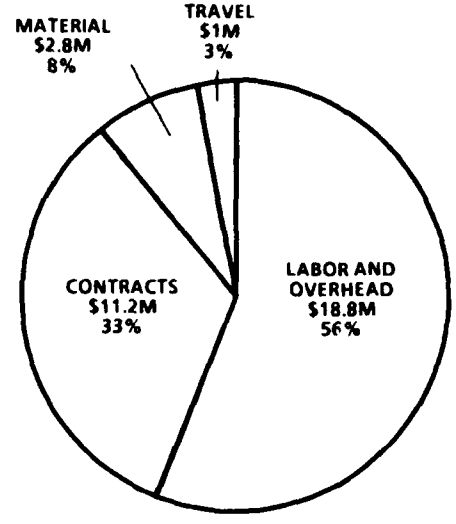
DISTRIBUTION OF FUNDS



FY87 ACTUAL



FY88 ESTIMATED



FY89 ESTIMATED

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NPRDC

LEADERSHIP ASSIGNMENTS

Personnel administration and organizational performance

Human performance

Manpower management

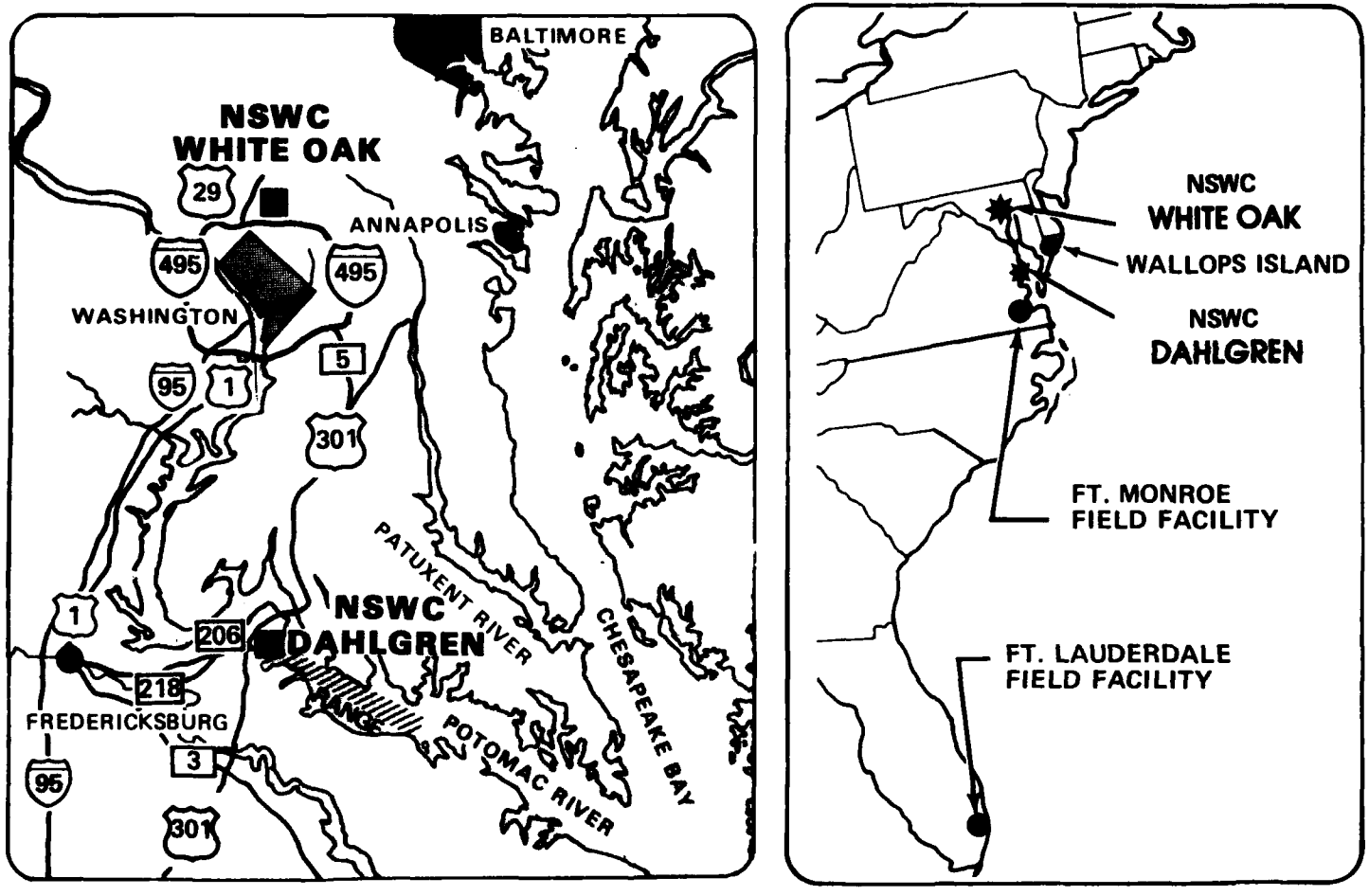
Human factors support to naval ships,
ship systems, and Marine Corps systems
(other than aircraft)

Instructional technology

30 SEPTEMBER 1987

NAVAL SURFACE WARFARE CENTER

BRIEF


BALTIMORE
NSWC
WHITE OAK
29
ANNAPOLIS
495
495
WASHINGTON
95
1
5
301
PATUXENT RIVER
NSWC
DAHLGREN
1
206
218
FREDERICKSBURG
3
95
301
POTOMAC RIVER
CHESAPEAKE BAY
NSWC
WHITE OAK
WALLOPS ISLAND
NSWC
DAHLGREN
FT. MONROE
FIELD FACILITY
FT. LAUDERDALE
FIELD FACILITY

MISSION...

TO BE THE PRINCIPAL NAVY RDT&E CENTER FOR SURFACE SHIP WEAPONS SYSTEMS, ORDNANCE, MINES, AND STRATEGIC SYSTEMS SUPPORT.

30 SEPTEMBER 1987

INTRODUCTION

The Naval Surface Warfare Center (formerly the Naval Surface Weapons Center) (NSWC) was established in 1974 with the merger of the Naval Ordnance Laboratory (NOL) at White Oak, Maryland, and the Naval Weapons Laboratory (NWL) at Dahlgren, Virginia. The merger of these two laboratories consolidated high-caliber human resources, extensive facilities, and long traditions of RDT&E in support of the fleet.

The Center also includes major field facilities at Ft. Lauderdale, Florida; Ft. Monroe, Virginia; and Wallops Island, Virginia.

The total funding of the Center in FY 1987 was $590 million. The Naval Sea Systems Command continues as the Center's major sponsor; funding about 48 percent of the Center's efforts. At the end of FY 1987 the Center employed 5,194 civilians, of whom 2,482 were engineers and scientists. The Center's military complement is 33 officers (in senior managerial billets and line assignments) and 67 enlisted personnel (many in specialized ratings).

The industrially funded Center performs technical support for customers in the Navy and other defense activities that need technical products and services for ship combat systems, ordnance, naval mines, and strategic systems. NSWC, with its primary mission in Surface Warfare, complements other Navy laboratories/centers that have primary missions in Air Warfare, Underwater Warfare, Naval Vehicles, etc.

Center functions are matched to the entire spectrum of technical activities needed in analyzing Navy needs, advancing Navy technology, developing and acquiring combat systems (with their sensors, weapons, and control subsystems), and supporting those systems deployed in the fleet.

The Center has a diverse and complex mix of facilities required to support research and development projects. These include the following: chemistry, plastics, metallurgy, robotics, and explosives laboratories; hydroballistic, hydroacoustic, and aerodynamic facilities; electromagnetic and environmental simulation facilities; combat/weapon systems integration and evaluation facilities.

The Center is responsible for Navy-wide leadership in the following areas: surface ship combat systems engineering and integration; surface warfare analysis; surface ship electromagnetic/electro-optic reconnaissance and search systems; surface ship gun and missile systems; mine, torpedo, projectile, and missile warheads; surface ship electronic warfare; Navy strategic systems targeting and fire control; mines; nuclear weapons effects; surface ship biological and chemical warfare systems; directed energy weapon systems; explosives (principally research); and mine, torpedo, and projectile fuzes.

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The Center has been developing a dynamic strategic planning process to assist in the development, application, acquisition, and training of its resources. The goal is to implement a process to ensure that the Center's resources are used in the most effective and efficient manner for providing the future needs of the Navy.

In the first iteration of this process, the Center chose to initiate a series of program and management thrusts. These thrusts were designed to focus internal efforts on a series of actions to achieve an appropriate balance in the development of new capabilities for providing the Navy with the systems it needs over the next 10 to 20 years. These thrusts are:

- Emphasize the technology, development, and integration of electronic warfare systems for the surface Navy and the Marine Corps
- Increase efforts in the development and application of offensive and defensive low observables technology
- Explore potential applications of artificial intelligence to Naval Systems
- Expand directed energy technology efforts; examine weaponization options and requirements
- Provide mission and weapons analyses to support the Navy's use of Space Systems
- Build technology capabilities needed to develop advanced autonomous ("brilliant") weapons
- Assess the potential for initiating development of surface-launched ASW weapons
- Enhance our capabilities to conduct single/multiple platform combat systems analysis and engineering
- Establish a centralized capability to conduct naval warfare requirements analysis
- Develop a strong tech base in information and system sciences
- Implement a systems design approach for all system and subsystem developments
- Reduce the level of in-house manpower devoted to software maintenance
- Upgrade or replace aging capital equipment and facilities
- Eliminate administrative and procedural barriers to effective performance
- Emphasize the technology and development of insensitive munitions

HISTORICAL HIGHLIGHTS IN THE CENTER'S EVOLUTION

1918 — Naval Proving Ground established at Dahlgren, Virginia.

1919 — Mine Unit and Experimental Ammunition Unit established at Washington Navy Yard.

1929 — Mine Unit and Experimental Ammunition Unit consolidated and renamed the Naval Ordnance Laboratory.

1948 — Naval Ordnance Laboratory relocated from Washington Navy Yard to White Oak, Maryland.

1950 — Naval Ordnance Laboratory Test Facility, Fort Monroe, established as a shore (field) activity.

1952 — Naval Ordnance Laboratory Test Facility, Fort Lauderdale, established as a shore (field) activity.

1957 — Naval Ordnance Laboratory Test Facility, Solomons, established as a shore (field) activity.

1959 — Naval Proving Ground name changed to Naval Weapons Laboratory.

1966 — The Naval Ordnance Laboratory and the Naval Weapons Laboratory came under the management control of the Chief of Naval Material.

1970 — Project REFLEX initiated at the Naval Weapons Laboratory, one of ten DOD laboratories selected to participate in a 3-year demonstration of feasibility to operate with no assigned personnel ceilings under fiscal controls only.

1972 — Naval Ordnance Laboratory Test Facilities at Fort Lauderdale, Solomons, and Fort Monroe disestablished as shore (field) activities; continued to operate as detachments of the Naval Ordnance Laboratory.

1973 — Propellant Sciences Department of the Naval Ordnance Station, Indian Head organizationally transferred to the Naval Ordnance Laboratory.

1974 — The Naval Ordnance Laboratory and the Naval Weapons Laboratory consolidated to form the Naval Surface Weapons Center.

1978 — Merged and organized by mission; departments within the Center to physically span laboratory location sites.

1981 — Naval Surface Weapons Center Detachment, Wallops Island, officially established.

1982 — Naval Surface Weapons Center Test Facility, Solomons, disestablished as a shore (field) activity.

1983 — Naval Surface Weapons Center Test Facility, Solomons transferred to the Naval Air Test Center, Patuxent River.

1987 — Naval Surface Weapons Center name changed to Naval Surface Warfare Center.

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HISTORY

The Dahlgren and White Oak sites of the Naval Surface Warfare Center both bring to the surface warfare community a long tradition of research and development that covers the entire spectrum from basic concept to proven hardware. Each site includes an extensive range of facilities, many of them unique, and some that complement capabilities at the other site. In concert, they command unparalleled physical and human resources.

Dahlgren was established in 1918 as the Naval Proving Ground, and named Dahlgren in honor of Rear Admiral John Adolphus Dahlgren, who is considered the father of modern naval ordnance. Prior to 1918, the Navy had operated a proving ground at Indian Head, Maryland, which became inadequate with advances in ordnance during World War I. A range of 90,000 yards down the Potomac River was provided by the move to Dahlgren.

However, Dahlgren was then an extremely remote area. Thus, to recruit and retain the highly specialized work force required, the Navy provided housing, food and medical services, schools and recreational facilities, and many other community services. Until World War II, the principal work at Dahlgren was to proof and test every major naval gun, along with the rounds they deliver, for Fleet use. This was done at the Main Range Gun Line which faces down the Potomac River.

While the Gun Line still performs that vital role, the scope and depth of work at Dahlgren has grown tremendously, as described elsewhere in this publication. Reflecting this expanded mission, and Dahlgren's transition to a broad-based R&D capability, the name was changed in 1959 to Naval Weapons Laboratory. Concurrently, the pace of change in the Dahlgren area has relieved the Navy of much of its role in providing community services. Dahlgren now has a land area of 4,300 acres that includes several miles of Potomac shoreline and a 20-mile downriver range for projectile testing.

White Oak traces its history to the establishment in 1919 of a Mine Unit at the Washington Navy Yard. A small group of experts was charged with making improvements in naval mines. Shortly after, a second group, the Experimental Ammunition Unit, joined the mine developers. In 1929, these two groups were consolidated and designated as the Naval Ordnance Laboratory.

As World War II approached, the NOL mission was greatly expanded and hundreds of technical personnel were recruited. During that war, NOL's principal achievements were the degaussing program for naval and merchant ships and the design of many ordnance devices, including the mines used to close down the Japanese home waters.

Anticipating NOL's future needs, the Navy acquired a large tract of land at White Oak, Maryland, to which the Laboratory moved in the late 1940s. The interests and capabilities of NOL led to a broad expansion in its suburban Washington location, which now comprises more than 200 buildings on about 730 acres. As the tide of Washington's growth continued its surge, NOL became a focal point of expertise in every field of physical science and engineering.

FIELD FACILITIES

DETACHMENTS

Evaluating weapon systems during development is a key part of the effort of NSWC. To provide field testing facilities, the Center staffs, manages, and operates three major field facilities located at Ft. Monroe, Virginia; Ft. Lauderdale, Florida; and Wallops Island, Virginia.

FT. MONROE

The Ft. Monroe Facility is adjacent to the Hampton Roads ship channel leading to the ports of Norfolk and Portsmouth, Virginia. Underwater ranges at Ft. Monroe and Ft. Story are used to collect data in support of the mine development program. Support capabilities include data collection and recording instrumentation, a computer-based optical tracking and plotting system, workboats for planting and recovering test units, and assembly shops.

FT. LAUDERDALE

The Ft. Lauderdale Facility assists and supports NSWC and other Navy activities in field tests of air, surface, and underwater weapons. Inert mines and torpedoes can be launched offshore from Navy tactical aircraft at speeds up to 500 knots. The Facility operates and maintains extensive underwater ranges with over 300 miles of instrumentation cable, magnetic sensor ranges, a 157-foot workboat, a 65-foot utility boat, underwater and surface tracking systems, underwater TV for object location and recovery, plus assembly and repair shops for all types of developmental systems. The unique environmental and physical characteristics of the geographical area include:

- Water depth of 2000 feet only 22 miles offshore.
- Hard sandy bottom and clear water for object recovery and diver operations.
- A variety of oceanographic conditions.
- Excellent climate for year-round test operations at sea.
- Major commercial harbor and port facilities.

WALLOPS ISLAND

The Wallops Island detachment is the site of the Combat Systems Laboratory (CSL). The CSL will be a research, development, and evaluation facility chartered to develop a corporate memory and high degree of engineering expertise in the nature and resolution of Battle Group level system engineering problems. The Combat Systems Laboratory addresses system engineering at the element, subsystem, combat system, as well as the Battle Group levels in all warfare areas.

FACILITIES

SELECTED FACILITIES

Some of the superior or unique facilities that enable the NSWC staff to pursue weapon development from basic research or exploratory development to the point of readiness for Fleet use are listed below.*

- Magnetic Structure Facility to study magnetic characteristics of ships, submarines, and satellites
- Naval Gun Evaluation Facility
- Special Effects Test Facility
- Chem/Bio Defense Lab Complex
- FBM DiscPack Production Facility
- Gunnery and Missile Range Complex
- Electromagnetic Vulnerability Test Facility
- Major Nuclear Weapons Effects Facilities
- One of the Navy's largest computer complexes
- Chemistry, Plastics, and Metallurgy Labs
- Fire Control Program Assurance Facility
- Explosion Effects Evaluation Complex

*A large number of tasks are carried beyond Fleet entry through In-Service Engineering

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- Wind Tunnels for aerodynamic research at speeds to Mach 18
- Hydroballistic Tank with 1.75 million gallon capacity for study of relatively large models at high speed entry
- Hydroacoustic Facility
- Laboratories for testing and research in the chemistry of explosives and propellants
- Extensive laboratory and field facilities for evaluating ordnance under natural and/or simulated conditions
- Surface Evaluation Facility provides state-of-the-art analysis of solid surfaces and interfaces to help solve materials problems in the Fleet
- The Combat System Laboratory at Wallops Island addresses system engineering at the element, subsystem, combat system, as well as Battle Group levels in all warfare areas
- The Program Assurance Facility is a large complex of shipboard gun and mission digital fire control computers and peripherals
- The Robotics Research and Development Laboratory conducts research in robotics technology and develops robotics systems for current and future fleet applications
- Brighton Dam Acoustic Facility
- Failure Analysis and Reliability Laboratory
- Explosive Test Facility is a massive, steel-lined, reinforced concrete blast chamber to confine the detonation of up to a 50-pound explosion

Land Owned/Leased:	5,084 acres
Buildings:	
RDT&E	1,604,320 sq. ft.
Administrative	302,707 sq. ft.
Other	1,166,234 sq. ft.
Acquisition Costs:	
Real Property (Classes I & II)	$131.3 million
Equipment (Classes III & IV)	$237.9 million

PROGRAM WORK

The Center is providing research, development, and/or support in the following major fields of effort:

COMBAT SYSTEMS

AEGIS

TOMAHAWK

Weapon Systems Architecture and Engineering

SURFACE-LAUNCHED WEAPONS SYSTEMS

AEGIS Gun Weapon System

STANDARD Missile

Vertical Launching System

TARTAR

16-Inch Gun Munitions

Aero/Structures Technology

Dragon Missile System

SMAW (Shoulder-Launched Multipurpose Assault Weapon)

UNDERWATER WEAPON SYSTEMS

Advanced Sea Mine

QUICKSTRIKE

CAPTOR

SEAL Weapons

Mine Improvement Program

Torpedo, MK 50

AN/SQQ-89(V)/I

STRATEGIC WEAPON SYSTEMS

SDI Simulator

GPS Geodetic Receiver

TRIDENT II

ELECTROMAGNETIC COMBAT

AN/SPY-1A Radar

AN/SLQ-32(V)

Intelligence Systems

MAGIS/IAC

Pulsed Power Technology

Multi-Sensor Integration

PROTECTION

CASINO

Nuclear Survival of Surface Ships

Shipboard Nuclear Weapon Security

Surface System Electromagnetic Compatibility

HERO (Hazards of Electromagnetic Radiation to Ordnance)

Magnetic Silencing

CW Countermeasures

TECHNOLOGY

Pulsed Power Technology

CHAIR HERITAGE

Explosives

Metal Matrix Composites

High-Energy Batteries

Undersea Warheads

MAJOR ACCOMPLISHMENTS FY 87

ELECTRONIC SYSTEMS

- Developed over 100 improvements to the AEGIS AN/SPY-1A Radar's computer program to enhance operator controls and performance display readouts.

- Sited radars and sensors at NSWC to provide Interim Site for Multi-Sensor Integration tests and support our role as technology leader for development of advanced Local Area AAW sensors including the NATO AAW Program. Sited radars and sensors include: the Flexar Radar System, Focal Plane Array/Infrared Search and Track System, the Laser Radar, the Radar Cross Section Instrumentation Radar, and the Mirror Track Radar.

- Certified and released a significant AN/SLQ-32 Electronic Warfare System revision to fleet unit threat libraries to support rapid raid response in potentially hostile areas of operation.

WEAPONS SYSTEMS

- Completed System and compatibility tests of simulated SM-2 Block IV propulsion systems for TOMAHAWK/Vertical Launch System (VLS).

- Completed STANDARD Missile MK 115 Mod 0 Product Improvement Study and Conceptual Design Review (CDR) of a new warhead (EX 125).

- Completed PHALANX Advanced Concepts Effectiveness Studies which led to a Tentative Operational Requirement (TOR) and Development Options Paper for Future Close-In Weapons Systems (CIWS).

- Built and tested (static and dynamic) Focused Ordnance Simulating Devices (FOSDIC) to obtain target damage data representative of a directional warhead to compare with that of a nondirectional warhead. The dynamic tests of FOSDIC were conducted near Mach 3 (at NWC's SNORT track) against a stationary target and indicated that current methods of using static data in dynamic engagement simulations are reasonable.

- Introduced a number of quick fix improvements and initiated BB Improvement Program (for fixes requiring development) to correct gunnery errors in 16-Inch Guns on BB-61 Class ships.

PROTECTION SYSTEMS

- Installed and initiated operation of the Tactical Gamma Ray Simulator (TAGS) facility to provide a major new Navy test capability to support radiation hardening of ship-launched tactical missiles.

- Provided key support to Chemical Warfare Defense joint service exercise, SOLID SHIELD '87.

- Transferred the technical development agent responsibility for the Magazine Security MK 1 to NOS, Louisville with no program slips due to the transition.

STRATEGIC SYSTEMS

- Completed development and delivered fire control software for test flights of the TRIDENT II Missile from Cape Canaveral. This software has been used to launch six successful test flights which have met or exceeded all mission objectives.

- Conducted extensive simulations of SDI engagements to determine the applicability of maritime resources to strategic defense which are having a direct impact on Navy policy decisions regarding SDI.

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MAJOR ACCOMPLISHMENTS (CONT'D)

- Initiated full operation of the TRIDENT II Facility at NSWC. This facility houses the TRIDENT II MK 98 MOD 1 and MOD 3 fire control systems, software generation system, secure data communication system, media preparation equipment, and classified storage facilities.

- Developed automatic weaving machine to make stable MK5 Reentry Body nosetips which will result in cost savings for first production buy of several million dollars.

COMBAT SYSTEMS

- Developed the TOMAHAWK AN/SWG-3 Block I Weapon Control System software which was installed on the CG-52 and DD-963, the first ships of their class to be configured with the MK 41 Vertical Launching System (VLS).

- Installed Shipboard Gridlock System (SGS) Baseline 2.0 software aboard BUNKER HILL (CG-52). SGS provides tremendous potential for a more coherent tactical battle picture, a prerequisite to effective Battle Group Defense.

- Passed certification (CMP) of the TOMAHAWK AN/SWG-2 Block 2 Weapon Control System software and CNO authorized it for operational deployment. This major system upgrade passed all FOT&E and safety approvals for deployment on Armored Box Launcher configured BB's, DD-963's, and CGN's.

RESEARCH AND TECHNOLOGY

- Developed and provided to industry, a rapid, cost-effective scale up procedure for a new insensitive explosive compound (NTO, 3-nitro-1,2,4-triazol-5-one) for use on all Navy platforms.

- Passed two major milestones in developing Charged Particle Beam (CPB) weapon technology.
  - Demonstrated beam steering
  - Measured shower cone

- Developed a metal matrix composite material substitute for two beryllium components in the Trident II guidance system which will reduce their cost by more than 50 percent.

UNDERWATER SYSTEMS

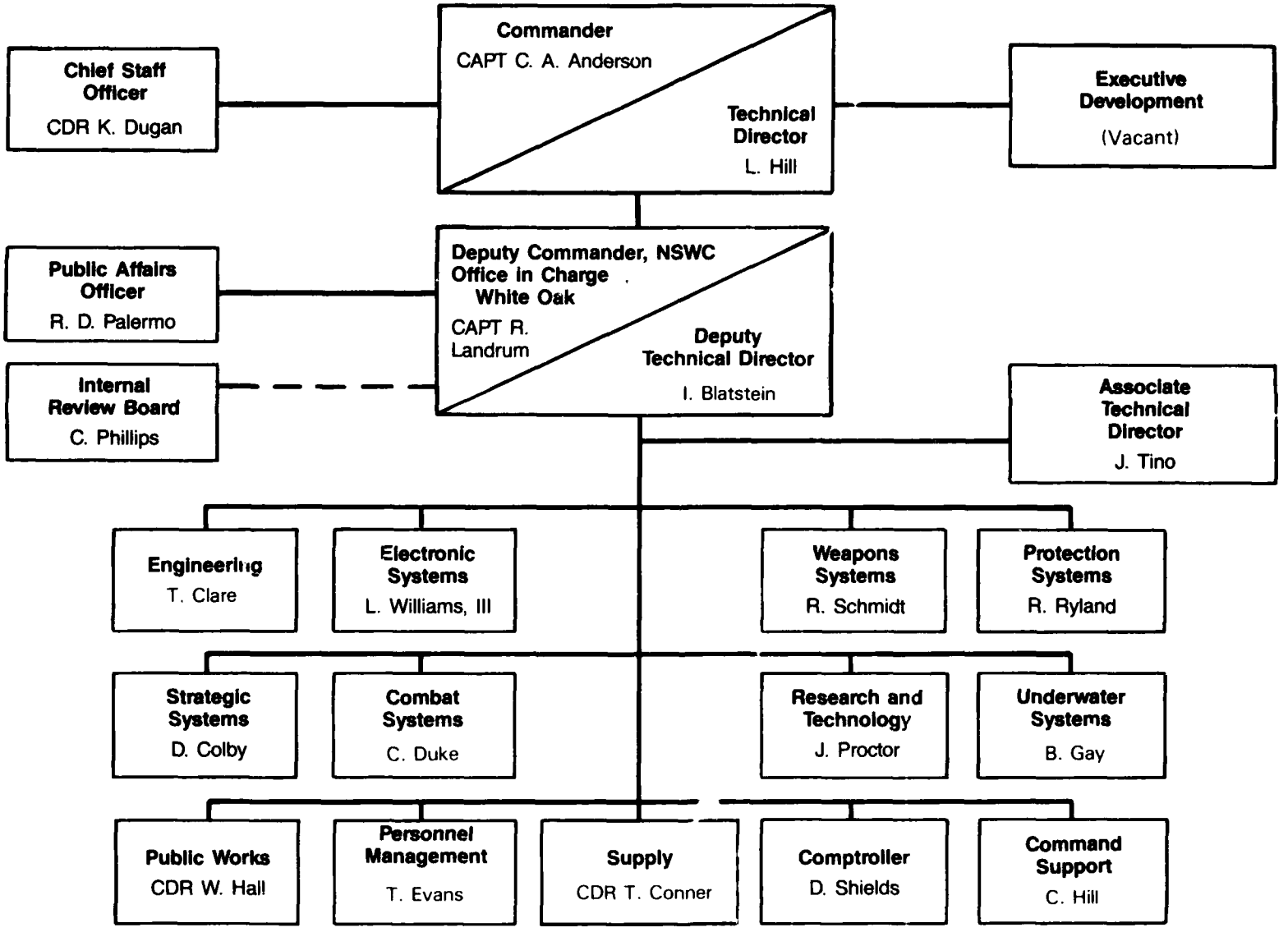
- Completed the design of an acoustic fuze for the Surface Ship Torpedo Defense (SSTD) Program which has produced excellent in-water test results.

- Tested the Warhead EX 122 for the Torpedo MK 50 at the maximum operating depth required of the torpedo and demonstrated that warhead performance meets the damage criteria established by the Navy.

- Completed Air Drop and Countermine Field Tests of the QUICKSTRIKE Target Detecting Device (TDD) MK 57 MOD 1 and B52 aircraft certification of QUICKSTRIKE Mines MK 63, MK 64, MK65 MOD 0, and MK 65 MOD 1.

- Completed development of the Underwater Warhead Analysis Facility used for the design and optimization of advanced warhead concepts and demonstrated its capability by successfully predicting performance of such weapons as the MK 50 Warhead and the ADV Limpet.

ORGANIZATION



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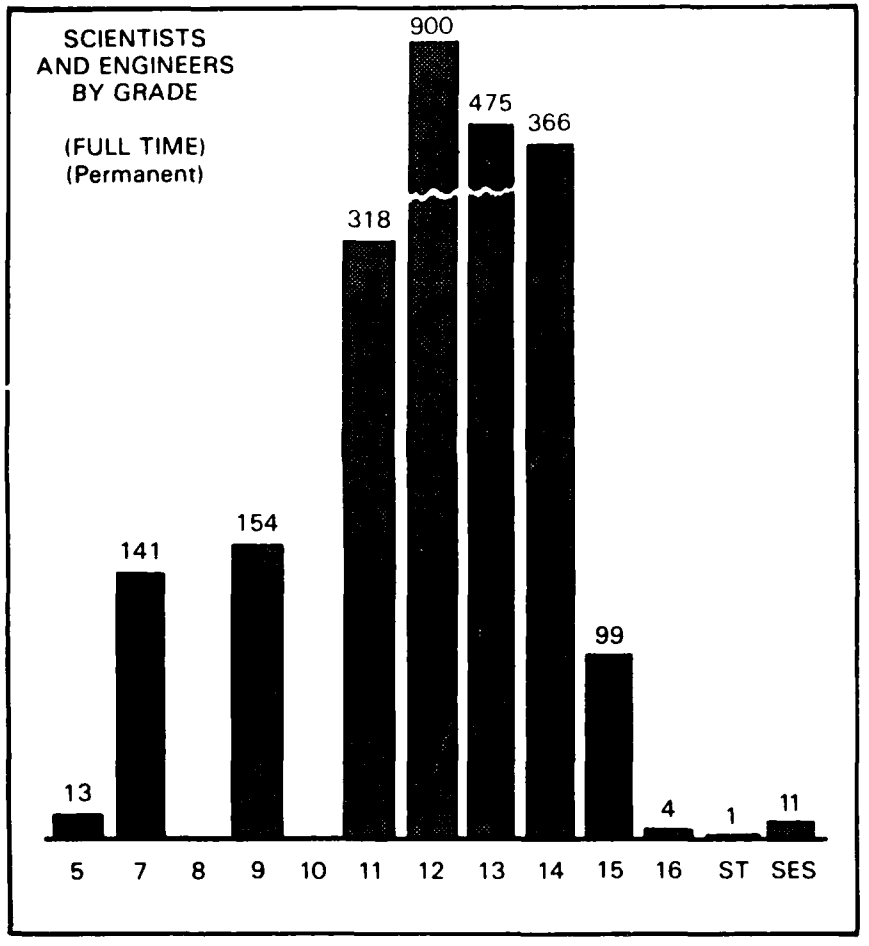
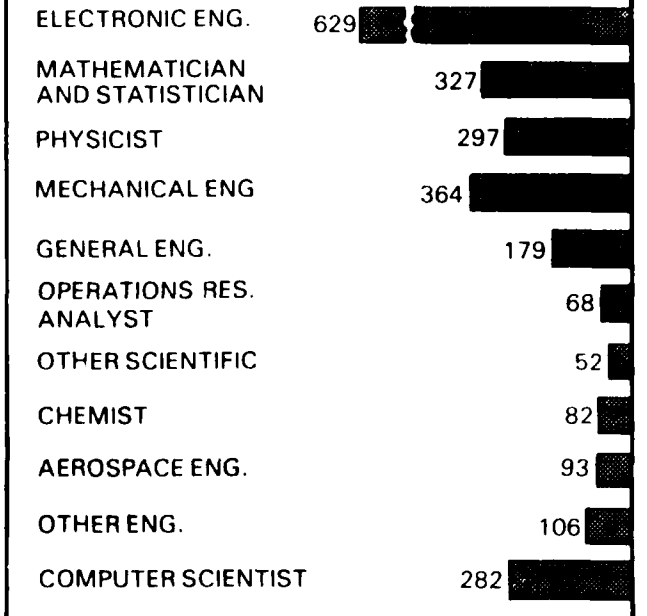
PERSONNEL DATA
September 1987



TOTAL PERSONNEL ON BOARD			
ONBOARD	5194	FTP* UNGRADED	541
TOTAL MILITARY	100	FTP* GRADED	4341
TOTAL CIVILIANS	5094	ADMINISTRATIVE	581
FTP*	4882	TECHNICIANS	826
TPTI**	212	SCIENTISTS & ENGINEERS (FTP)	2482
		OTHER	452

SCIENTIFIC AND ENGINEERS PERSONNEL BY DISCIPLINE
(Full-Time Permanent)



*Full-time permanent

**Temporary part-time, intermittent (not including summer hires exempt from ceiling controls).

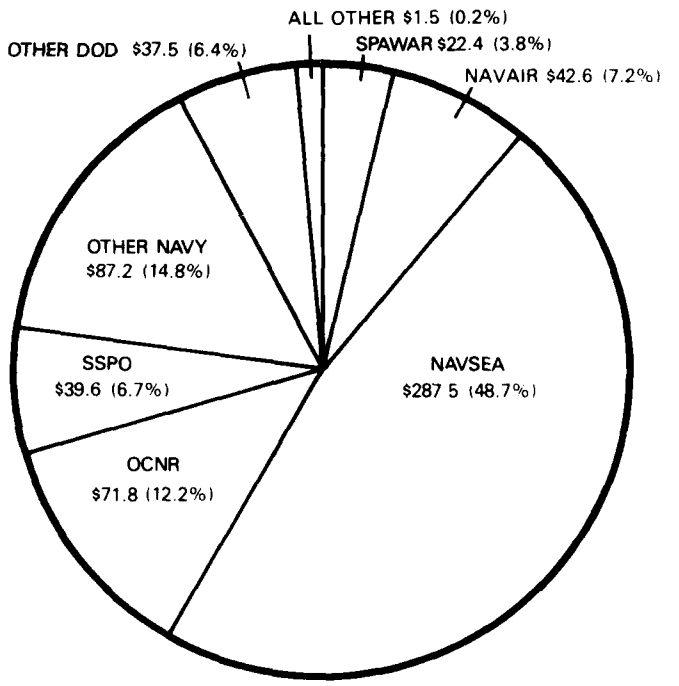
30 SEPTEMBER 1987

SOURCE OF FUNDS

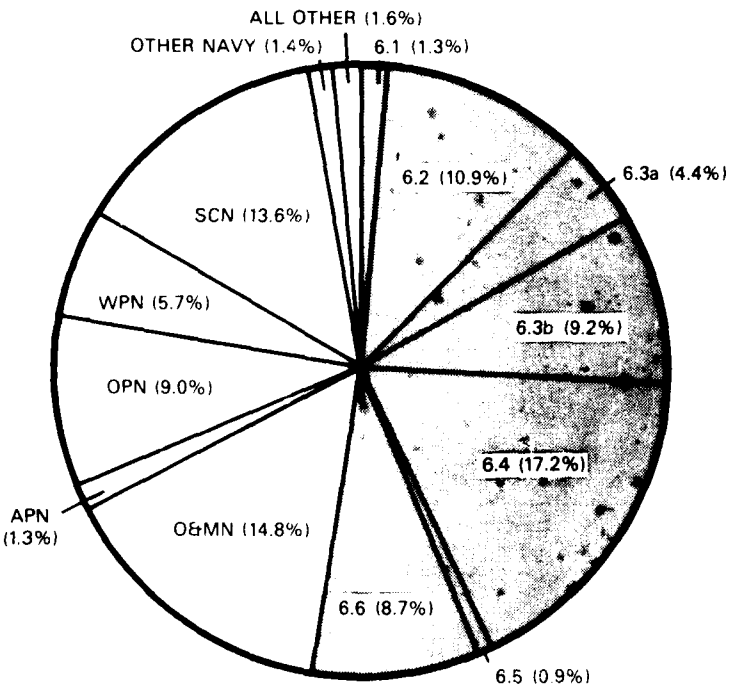
FY 1987—ACTUAL $590.1

NOR
$ IN MILLIONS

FUNDING BY SPONSOR



FUNDING BY APPROPRIATION



SPAWAR	—SPACE AND NAVAL WARFARE SYSTEMS COMMAND
NAVAIR	—NAVAL AIR SYSTEMS COMMAND
NAVSEA	—NAVAL SEA SYSTEMS COMMAND
OCNR	—OFFICE CHIEF OF NAVAL RESEARCH
SSPO	—STRATEGIC SYSTEMS PROJECT OFFICE

O&MN	—OPERATIONS AND MAINTENANCE, NAVY
APN	—AIRCRAFT PROCUREMENT, NAVY
OPN	—OTHER PROCUREMENT, NAVY
WPN	—WEAPONS PROCUREMENT, NAVY
SCN	—SHIPBUILDING & CONVER., NAVY

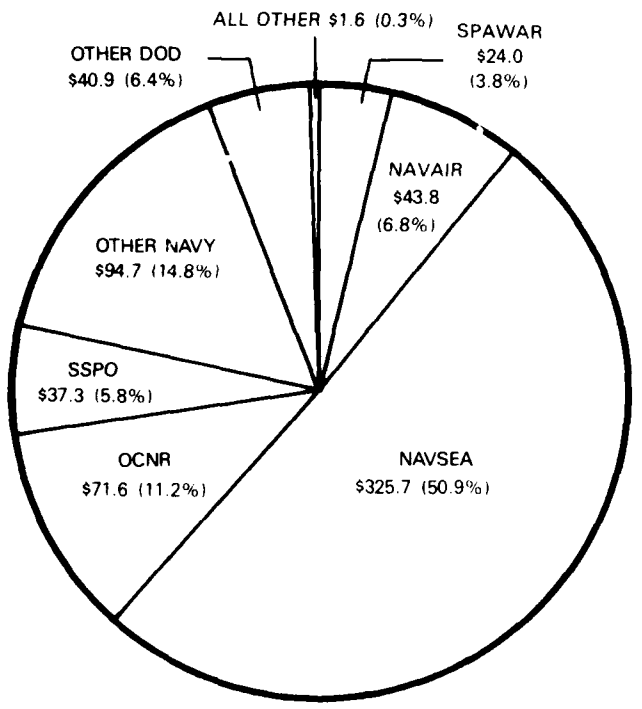
30 SEPTEMBER 1987

SOURCE OF FUNDS

FY 1988—ESTIMATED $639.6

NOR
$ IN MILLIONS

FUNDING BY SPONSOR



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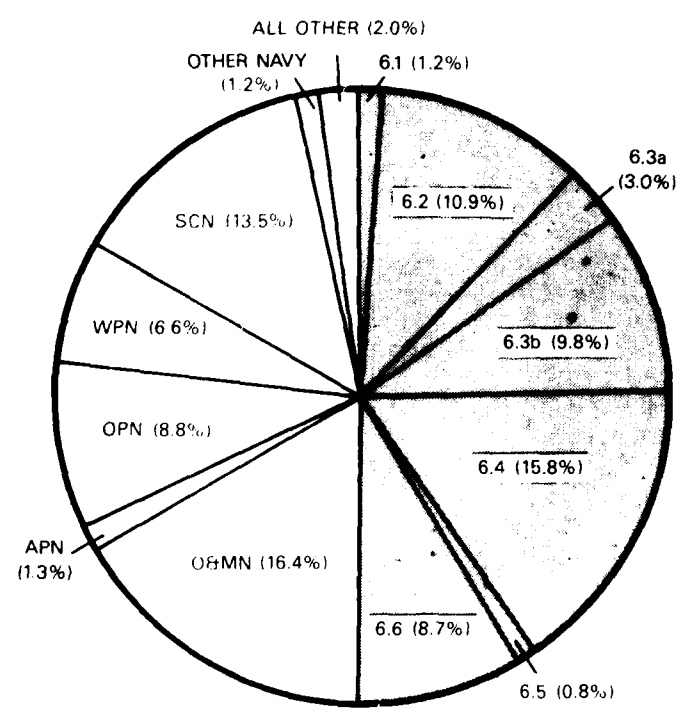


O&MN - OPERATIONS AND MAINTENANCE, NAVY
APN - AIRCRAFT PROCUREMENT, NAVY
OPN - OTHER PROCUREMENT, NAVY
WPN - WEAPONS PROCUREMENT, NAVY
SCN - SHIPBUILDING & CONVER., NAVY

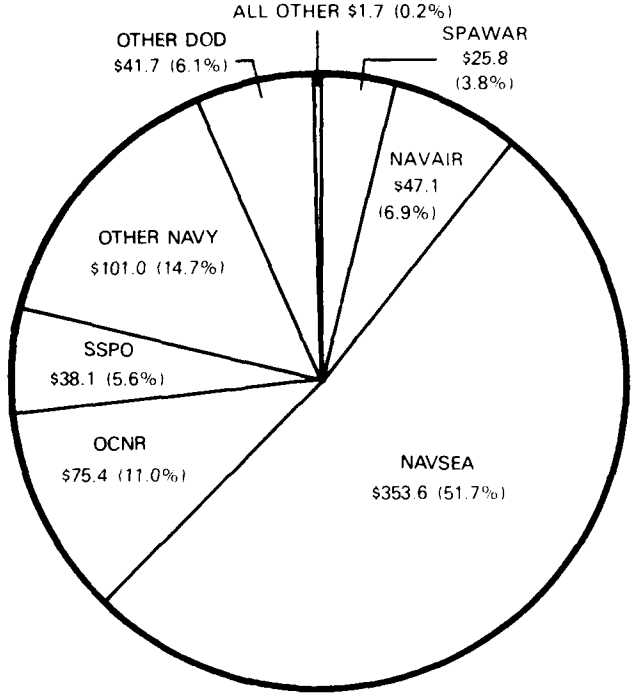
30 SEPTEMBER 1987

SOURCE OF FUNDS

FY 1989—ESTIMATED $684.4

NOR
$ IN MILLIONS

FUNDING BY SPONSOR



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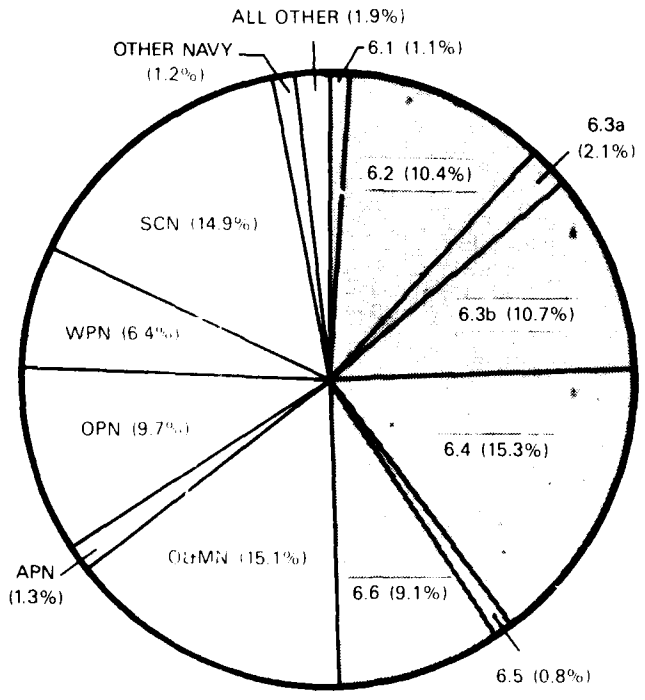

SPAWAR	– SPACE AND NAVAL WARFARE SYSTEMS COMMAND
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OPN	OTHER PROCUREMENT, NAVY
WPN	WEAPONS PROCUREMENT, NAVY
SCN	– SHIPBUILDING & CONVER., NAVY

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NOR
$ IN MILLIONS

FUNDS BY CATEGORY AND TYPE

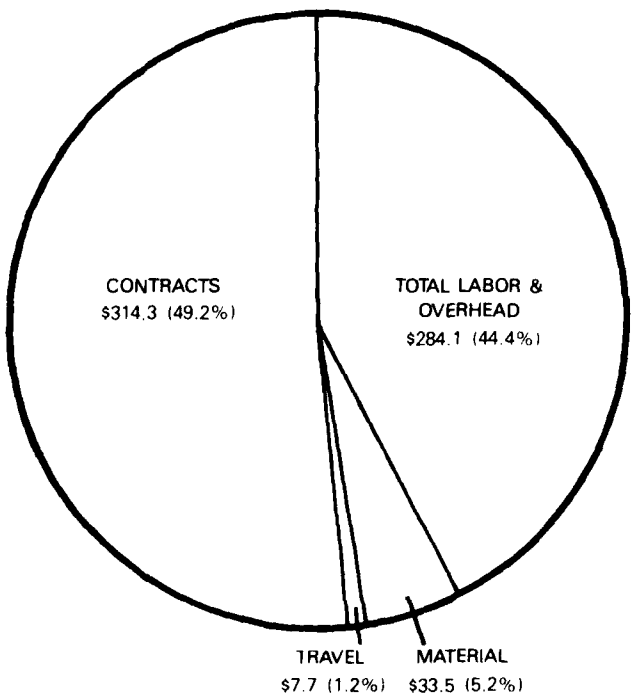
CATEGORIES & TYPE	FY 1987			FY 1988			FY 1989		
	$M ACT.	% OF RDT&E	% OF TOTAL	$M EST.	% OF RDT&E	% OF TOTAL	$M EST.	% OF RDT&E	% OF TOTAL
RDT&E (CATEGORY)									
6.1 RESEARCH	7.8	2.5	1.3	7.5	2.3	1.2	7.7	2.3	1.1
6.2 EXPLORATORY DEVELOPMENT	64.1	20.6	10.9	70.0	21.8	10.9	71.2	21.0	10.4
6.3a ADVANCED TECHNOLOGY DEVEL.	26.2	8.5	4.4	19.0	5.9	3.0	14.6	4.3	2.1
SUBTOTAL	98.1	31.6	16.6	96.5	30.0	15.1	93.5	27.6	13.6
6.3b ADVANCED DEVELOPMENT	54.1	17.4	9.2	63.0	19.6	9.8	73.4	21.6	10.7
6.4 ENGINEERING DEVELOPMENT	101.8	32.8	17.2	100.8	31.4	15.8	104.9	30.9	15.3
6.5 MANAGEMENT AND SUPPORT	5.4	1.7	0.9	5.2	1.6	0.8	5.4	1.6	0.8
6.6 OPERATIONAL SYSTEMS DEVEL.	51.3	16.5	8.7	55.7	17.4	8.7	61.9	18.3	9.1
SUBTOTAL	212.6	68.4	36.0	224.7	70.0	35.1	245.6	72.4	35.9
TOTAL RDT&E	310.7	100.0	52.6	321.2	100.0	50.2	339.1	100.0	49.5
(O&MN) OPER. & MAINT., NAVY	87.1		14.8	104.9		16.4	103.6		15.1
(APN) AIRCRAFT PROCUREMENT, NAVY	7.8		1.3	8.3		1.3	8.6		1.3
(OPN) OTHER PROCUREMENT, NAVY	52.9		9.0	56.6		8.8	66.6		9.7
(WPN) WEAPONS PROCUREMENT, NAVY	33.9		5.7	42.0		6.6	43.4		6.4
(SCN) SHIPBUILDING & CONVER., NAVY	80.2		13.6	86.2		13.5	102.0		14.9
OTHER NAVY	8.2		1.4	7.5		1.2	8.1		1.2
ALL OTHER	9.3		1.6	12.9		2.0	13.0		1.9
OTHER APPROPRIATION SUBTOTAL	279.4		47.4	318.4		49.8	345.3		50.5
TOTALS	590.1		100.0	639.6		100.0	684.4		100.0

30 SEPTEMBER 1987

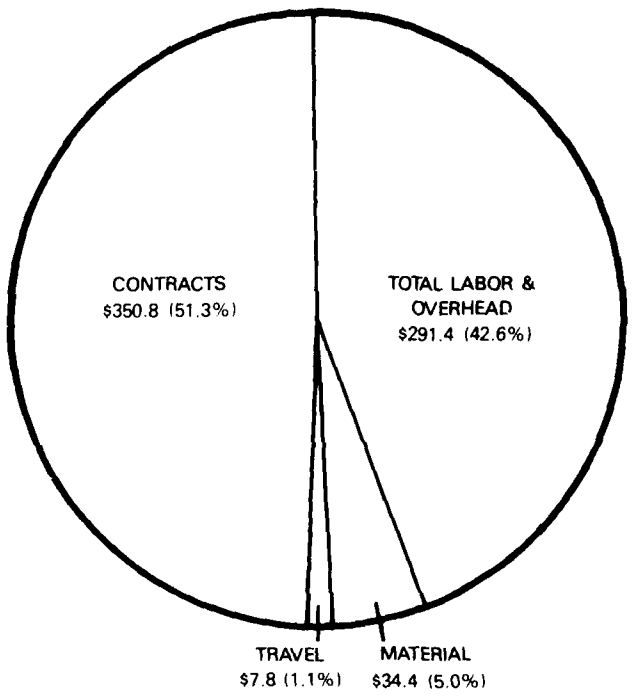
NOR
$ IN MILLIONS

DISTRIBUTION OF FUNDS

FY 1988 — ESTIMATED $639.6



FY 1989 — ESTIMATED $684.4



30 SEPTEMBER 1987

LEADERSHIP ASSIGNMENTS

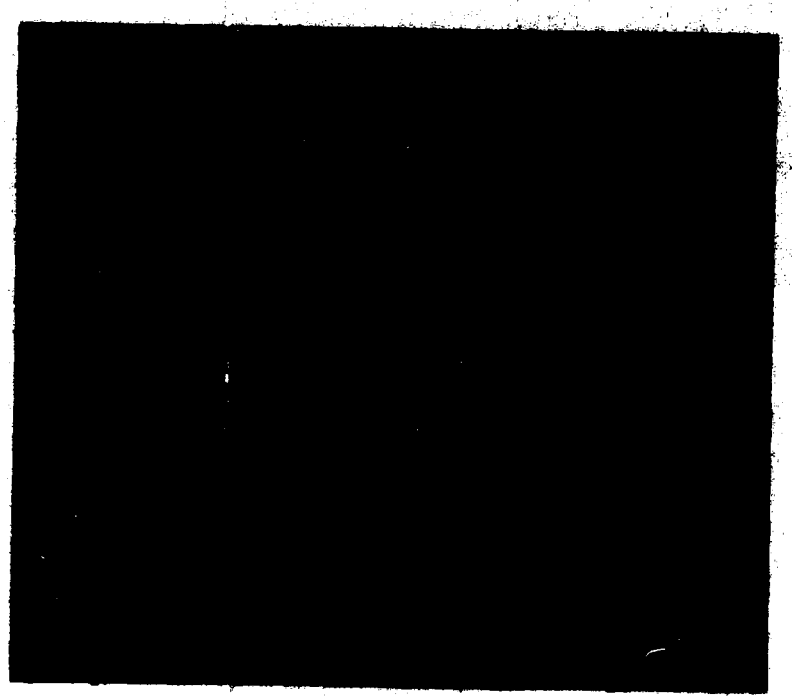
As Assigned by NAVMAT Instruction 5450.27C of 1 August 1983

The Naval Surface Warfare Center is responsible for Navy-wide leadership in:

- Surface ship combat systems engineering and integration
- Surface warfare analysis
- Surface ship electromagnetic/electro-optic reconnaissance and search systems
- Surface ship gun and missile systems
- Mine, torpedo, projectile, and missile warheads
- Surface ship electronic warfare
- Navy strategic systems targeting and fire control
- Mines
- Nuclear weapons effects
- Surface ship biological and chemical warfare systems
- Directed energy weapon systems
- Explosives (principally research)
- Mine, torpedo, and projectile fuzes

AERIAL VIEW OF DAHLGREN SITE AND WHITE OAK SITE

Dahlgren



White Oak

NSWC AP 88-2
Approved:
1 January 1988

C. A. Anderson
Captain, U.S. Navy
Naval Surface Warfare Center

NAVAL SURFACE WARFARE CENTER

BRIEF

NUSC

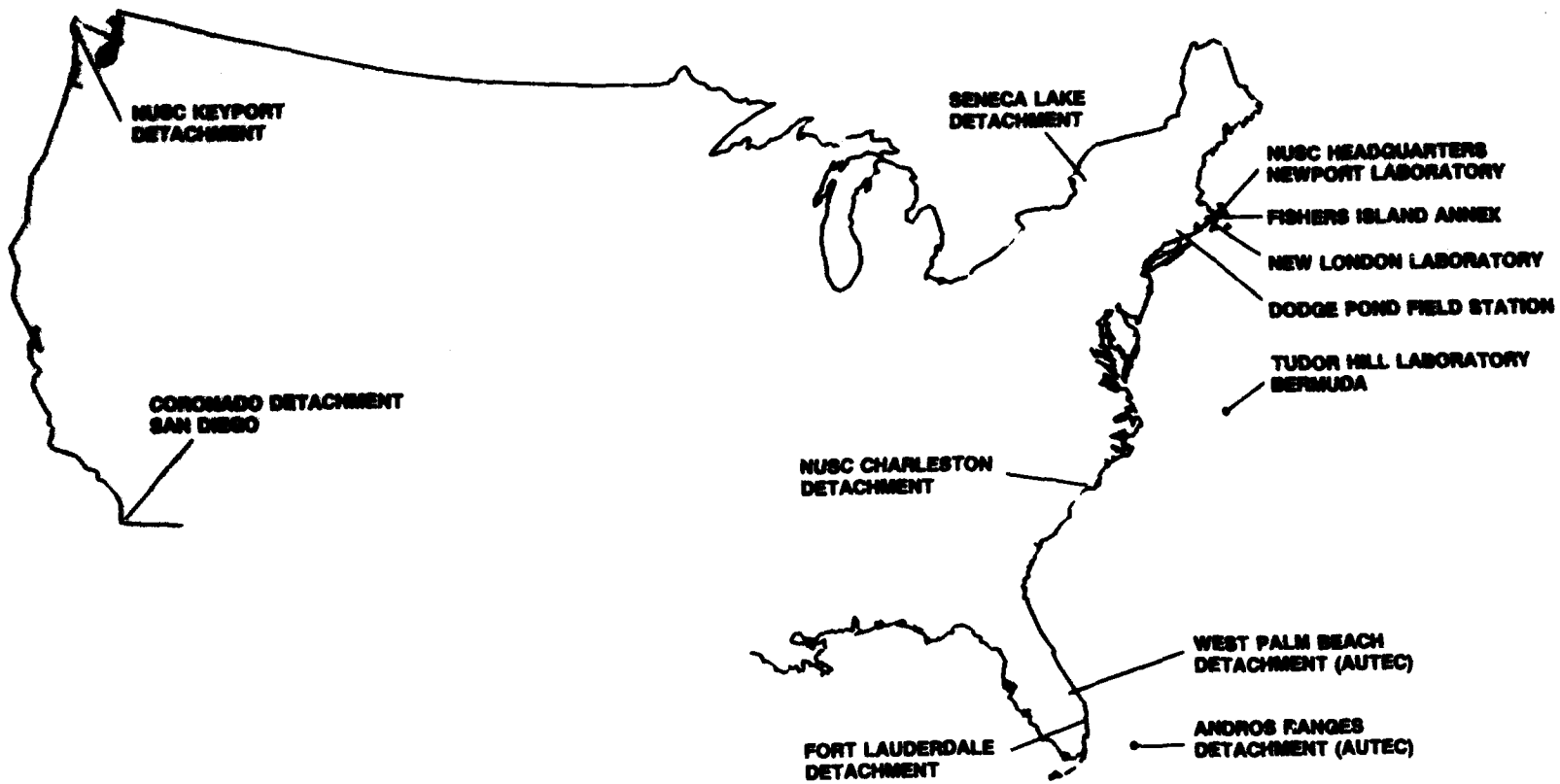
Newport, Rhode Island – New London, Connecticut

Naval Underwater Systems Center Brief

Containing Data for the Fiscal Year
Ending 30 September 1987

NUSC ASSETS

Location of NUSC's major laboratories and detachments.



30 September 1987

NUSC MISSION

To be the principal Navy Research, Development, Test and Evaluation (RDT&E) Center for submarine warfare and submarine weapon systems.

30 September 1987

NUSC INTRODUCTION

The Naval Underwater Systems Center (NUSC) is the Navy's principal RDT&E Center for submarine warfare and submarine weapon systems. NUSC has two major laboratories in Newport, RI, and in New London, CT. Headquarters is located in Newport. NUSC's major detachments are in Bermuda, West Palm Beach, FL, and at the Atlantic Undersea Test and Evaluation Center in the Bahamas. NUSC also operates a large acoustic test facility at Seneca Lake, NY.

NUSC was formed in 1970 by the merger of the Naval Underwater Weapons Research and Engineering Station in Newport, RI, and the Naval Underwater Sound Laboratory in New London, CT. The Newport laboratory dates to the establishment of the Naval Torpedo Station in 1869. Over the years, through two world wars and the extraordinary acceleration of technology in the past three decades, the original work in torpedoes has grown into full-spectrum responsibility for underwater weapon systems. The New London Laboratory traces its origin to World War II when the Underwater Sound Laboratory was established to take up the sonar work of Columbia University's New London Laboratory and Harvard's Cambridge Laboratory. Since that time, the New London Laboratory has been the driving force behind virtually all major ship sonar systems.

NUSC is organized into major product line directorates and departments, in addition to a number of support departments and staffs. NUSC's principal product lines are:

- *Submarine integrated combat systems*
- *Submarine sonar*
- *Surface ship sonar*
- *Submarine electromagnetic systems*
- *Submarine combat control systems*
- *Torpedo systems*
- *Submarine tactical missile systems*
- *Launcher systems*
- *Underwater target simulators*
- *Undersea ranges development and operation*
- *Warfare analysis*

NUSC maintains a strong and relevant RDT&E program, and also provides high-quality, responsive support to the fleet. In this context, NUSC is considered a full-spectrum Center – it must stay involved to a certain degree with in-service systems to maintain a real-world appreciation of the operational environment, to improve design weaknesses, to counter the evolving threat, and to apply new technology. Rapid transition and insertion of technology into the fleet are vital elements of this process.

30 September 1987

NUSC FACILITIES

NUSC principal laboratories are in Newport, RI, and New London, CT, with major detachments at Tudor Hill, Bermuda; West Palm Beach, FL; and at the Atlantic Undersea Test and Evaluation Center (AUTEC) in the Commonwealth of the Bahamas.

Land Owned/Leased

Total	**1369 acres**

Buildings

RDT&E	1,249,951 sq ft
Administrative	223,737 sq ft
Other	850,578 sq ft
Total	**2,324,266 sq ft**

Acquisition Costs

Real Property (Classes I & II)	$431 M
Equipment (Classes III & IV)	$109 M
Total	**$540 M**

NUSC's ability to perform its mission is made possible by facilities such as the following (a selected list, organized by cognizant NUSC department):

Research and Technology Staff (Code 10)

Acoustic Turbulent Water-Flow Tunnel: for investigating turbulence induced self-noise of hydrophones.

30 September 1987

Submarine Sonar Department (Code 21)

Transducer Measurements Laboratory: for measuring, testing, and developing transducers for sonar systems.

Towed Array Facility: for assembly of acoustic towed arrays and vibration isolation modules.

Transducer Model Shop: for fabricating and testing prototype transducers.

SSN Sonar Simulation Laboratory: for laboratory testing and evaluation of sonar systems.

Computer Displays Laboratory: for evaluating sonar display formats.

Man-Machine Sonar Test Bed: for developing and evaluating methods to improve the operability of sonar systems.

Surface Ship Sonar Department (Code 33)

Sonar Development Evaluation Complex: containing stand-alone and integrated configurations for various types of sonar equipment, such as AN/SQQ-89(V). This test site provides the capability for individual sonar system development, testing, operator training, life-cycle support and integrated system test and evaluation.

Digital Computer Facility: a sea-going digital computer system for real-time acquisition and processing of underwater acoustic data.

Sonar System Computer Facility: a multicomputer facility for developing new digital computer techniques in sonar systems, special signal processing circuits, and new displays.

Software Development Facility: for developing software applications programs to support modernization of current surface ship sonar systems.

NUSC FACILITIES

Submarine Electromagnetic Systems Department (Code 34)

Antenna Testing Facilities: for determining antenna radiation characteristics needed to develop and evaluate submarine antenna systems. Includes a field facility on Fishers Island, NY, primarily for mast-mounted and buoyant cable antennas; a unique arch over a seawater ground plane for testing satellite communication antennas; and a complex of indoor shielded enclosures, anechoic chambers, and roof-top ranges for testing antenna radiation patterns.

SSN 688 Radio Room Facility: an operational radio room that supports performance baseline work, systems engineering, combat systems interface testing, and real environment problem solving.

Fiber Optic Laboratory: a fully equipped laboratory for fiber optics RDT&E, including scanning electron microscope and automated electronics/optics testing instrumentation.

Periscope R&D Test Facilities: for periscope research, development, and configuration control work, with periscopes in either vertical or horizontal positions.

Combat Control Systems Department (Code 22)

Combat System Technology Laboratory: to support the development and evolution of hardware, software, and system technology applicable to advanced combat systems concepts.

Combat Control Systems Improvement Program Facility: for development, testing, integration, and certification of major improvements to submarine Combat Control System Mk1.

Advanced Combat System Interactive Design Laboratory: to conduct attack center scripted scenarios to address issues of operability and maintainability, and to evaluate advanced human engineering and operability concepts through realistic, real-time interaction between personnel and working equipment.

Torpedo Systems Department (Code 81)

Mk 48 Torpedo Facility: duplicates a fleet intermediate maintenance activity facility; used to support in-service engineering tasks to validate Mk 48 weapon engineering change proposals.

Mk 48 ADCAP Software Life Cycle Support Lab: supports evaluation and maintenance of software for the advanced capability Mk 48 torpedo.

Propulsion Test Facilities: for testing of all types of thermal and electric torpedo propulsion systems.

Weapon Systems Technology and Assessment Department (Code 82)

Experimental Vehicles Laboratory: for integrating advanced weapon and target technology into operational research test vehicles.

Sea Water Towing Tank (Langley): for use in drag reduction testing.

Target Life Cycle Support Facility: for integration of technology into prototype vehicles and for mechanical, electronic, electrical, and software support of existing and developmental mobile targets.

Indoor Acoustic Tank: the largest in the U.S., measuring 40 by 40 by 60 feet.

30 September 1987

NUSC FACILITIES

Launcher and Missile Systems Department (Code 83)

Submarine Torpedo Tube Launching Facility (Bldg 113): for torpedo firing tests at simulated depth to study improved or newly developed torpedo tube and ejection system techniques and to analyze in-service discrepancies.

Submarine R&D Torpedo Tube Launching Facility (Bldg 1246): for torpedo firing tests of 688-class submarines at simulated depths permitting the evaluation of new concepts in launching systems leading to future systems with improved performance and reduced acoustic signature.

Flow Loop Facility: for the analyses of both steady state and accelerating fluid flow in the study of launch dynamics, pump impeller designs, and acoustics.

Submarine Internal Auxiliary Launcher Test Facility: for small device firing tests at simulated depth to evaluate both near-term and future small-diameter auxiliary launcher system performance.

Surface Ship Torpedo Tube and Loading Equipment Test Facility: for analysis, development, and evaluation of new equipment, equipment changes, and alterations.

Missile Engineering Laboratory: provides RDT&E and fleet readiness support for non-strategic submarine-launched missiles.

Surface Ship Missile Launcher and Loading/Handling System Facility: for analysis of in-service casualties, development and evaluation of new equipment, and proofing of equipment changes and alterations.

30 September 1987

Test and Evaluation Department (Code 38)

Newport Underwater Ranges: an underwater tracking and sound measurement complex supporting RDT&E in underwater weapons and launchers.

Towed Array Test and Evaluation Facility (TATEF), Fort Lauderdale, FL: for staging and conducting at-sea test and evaluation of all Navy towed sonar arrays.

Seneca Lake Acoustic Measurement Facility, Dresden, NY: for test and evaluation of large sonar arrays/systems and low-frequency transducers requiring deep-water, fixed geometry, and heavy-load handling capabilities.

Range Development Laboratories: for design, fabrication, test, and evaluation of underwater tracking and acoustic measurement range systems, devices, and analysis techniques.

Tudor Hill Laboratory, Bermuda: for deep-ocean acoustic research programs covering a broad frequency range.

Atlantic Undersea Test and Evaluation Center (AUTEC), Andros Island, Commonwealth of the Bahamas: for test and evaluation of total ASW combat systems, both developmental and operational. Ranges include two 3-D weapons ranges, a permanent acoustic measurement range, a fleet operational readiness accuracy check site for alignment of ASW sensors, and an ocean haul-down facility. A NUSC detachment at West Palm Beach, FL, provides logistic support for the AUTEC ranges.

NUSC FACILITIES

Engineering and Technical Support Department (Code 40)

Materials Measurements Laboratory: contains state-of-the-art equipment for obtaining measurements not generally available, but which are essential for accurate material characterization for use in computer simulation studies.

Hybrid Thick Film Laboratory: to design and build hybrid thick film circuits, including surface mount devices, for use in advanced engineering designs.

Environmental Test Laboratories: contain equipment for a full spectrum of environmental tests; capable of performing tests on all systems for which NUSC is cognizant.

Industrial Support Facilities: fully equipped machine shops (including computer-controlled machines) and electrical shops; includes auxiliary industrial capabilities such as welding, fiberglass lay-up, rubber molding, woodworking, etc. Used for prototyping, temporary equipment installation, equipment modification, and repair.

Instrumentation Development Laboratory: used to develop specialized instrumentation and interface equipment — particularly for use in sea tests. The laboratory includes tape recording capabilities for use in a variety of test situations.

Computer-Aided Design and Analysis Facilities: for RDT&E designs, mechanical and electronic; includes three-dimensional modeling for conceptual designs, generation of numerical control data for machine tools in industrial support facilities, and finite element geometric modeling.

30 September 1987

Combat Systems Analysis Department (Code 60)

Combat Systems Analysis Products and Techniques Facility: dedicated hardware and flexible software that can be configured to provide comprehensive reconstruction and analysis support of a variety of fleet ASW exercises and operations, as well as technical/operational evaluations.

Sensitive Compartmented Information (SCI) Facilities: dedicated spaces in New London and Newport for conducting SCI work. The larger facility in New London also contains laboratory equipment spaces used by various departments.

Computer & Information Services Department (Code 70)

Distributed Computer Network (NUSCNET): links computing resources throughout NUSC via local area networks.

Computer-Aided Engineering and Documentation System (CAEDOS): provides computer-aided engineering/documentation resources at each laboratory.

Secure Video Teleconferencing (VTC) Network: improves communications, enhances productivity, and saves both time and money by allowing interactive audio and video conferencing (both unclassified and classified) by individuals geographically separated. The NUSC VTC network, with facilities at Newport, RI, and New London, CT, has been operational since Nov 85. A third site will be implemented at NAVSEA during 1988. This innovative communications network is the model for the Navy and DoD.

Computer Facilities: provide general-purpose computational resources for all NUSC employees.

NUSC PROGRAM WORK

The following provides a sample of the programs and program work NUSC supports in carrying out its mission and leadership responsibilities. All programs are fully supported in the reliability, maintainability, system safety, and quality assurance disciplines. Selected programs are subject to life-cycle cost analysis, cost/benefit analysis, and cost/operational effectiveness analysis.

Warfare Analysis

- Warfare Systems Architecture and Engineering
- Exploitation Analysis of U.S. and Foreign Torpedoes
- Submarine and Surface Ship ASW Effectiveness Studies
- ASW Test Bed Development
- Simulation Model Development and Evaluation
- Assessment Support to Intelligence Community
- Technical Reconstruction and Analysis of Fleet Exercises and Operations
- NUSC Personnel Assignments to Fleet Commands
- R&D/Technology Investment Strategy Development
- Fleet Operating Guidelines and Computer-Based Acoustic Performance Prediction Products

Combat System Engineering and Integration

- SSN 21 Platform Integration, Sonar, and Combat System Development; AN/BSY-2/BQG-5 Submarine Combat System (Technical Direction Agent)
- AN/BSY-1(V) Combat Control Acoustic Set (Technical Direction Agent)
- AN/SQQ-89 Surface ASW Combat System (Technical Direction Agent)

Submarine and Surface Ship Sonar Systems

- AN/BQQ-5 SSN Sonar
- AN/BQQ-6 SSBN Sonar (Technical Direction and Systems Engineering Agent)
- Wide Aperture Array (Technical Direction and Systems Engineering Agent)
- Advanced Conformal Submarine Acoustic Sensors
- Submarine Active Detection Sonar
- Mine Detection and Avoidance Sonar
- AN/UYS-2 Enhanced Modular Signal Processor (Technical Direction and Systems Integration Agent)
- Acoustic Communications
- Environmental Acoustics
- Sonar Domes, Baffles, and Coatings
- AN/SQS-26 and -53A Surface Ship Sonars (Technical Direction Agent)
- Surface Ship Torpedo Defense System
- AN/SQR-18 Towed Array Sonar
- AN/SQQ-89(B) (Technical Direction Agent)
- AN/SQQ-89(I) (Technical Direction Agent)

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NUSC PROGRAM WORK

Submarine Electromagnetic/Electro-Optic Reconnaissance, Search, and Communications Systems

- Submarine Periscopes (Technical Direction, Design, Acquisition Engineering, and In-Service Engineering Agent for all Fleet Periscopes)
- Submarine Electronic Warfare
- Submarine Integrated Antenna Systems
- Navy Extremely High Frequency Satellite Communications
- Extremely Low Frequency Communications
- SSN External Communications System
- Submarine Communications Systems Engineering
- Electromagnetic Compatibility
- Electro-optics/Marine Optics
- Navy High-Frequency, Anti-Jam Communication System
- Submarine Air Force Satellite System
- Submarine Satellite Communication Buoys

Submarine Combat Control Systems

- Combat Control System Mk 1 (Technical Direction Agent)
- Trident Mk 118 Defensive Weapon System (Technical Direction Agent)
- In-Service Engineering for Submarine Fire Control System
- RANGEX Program (Open Ocean, Arctic)
- Adaptable Expert Systems
- Combat Control System Improvement Program
- Tomahawk Missile Integration
- Tactical Embedded Computer Resources
- Software Technology
- Submarine Underwater Combat Control Block Program

Launcher Systems

- SSN 21 Launchers
- High Speed and Covert Torpedo Launch Technology
- Submarine Turbine Pump Ejection Systems Mk 17 and Mk 19 (Technical Direction and In-Service Engineering Agent)
- Submarine Torpedo Tubes Mk 59, 63, 65, 67, and 68 (Technical Direction and In-Service Engineering Agent)
- ASROC/Harpoon Launching Group Mk 16 (Technical Direction and In-Service Engineering Agent); Launcher Guide Mk 114 Development; ASROC Weapon Handling System
- Surface Ship Torpedo Tubes Mk 25 and 32 (Technical Direction and In-Service Engineering Agent)
- Submarine Weapon Handling Systems (In-Service Engineering Agent)
- SSN-688 Vertical Launch Systems (In-Service Engineering Agent)
- Weapon/Submarine Pre- and Post-Launch Communication Systems

30 September 1987

NUSC PROGRAM WORK

Submarine ASW Tactical Missile Systems

- Encapsulated Harpoon Weapon System (Submarine Systems Integration Agent)
- Sea Lance ASW Standoff Weapon (Technical Direction, Acquisition Engineering, and In-Service Engineering, and Submarine Systems Integration Agent)
- Tomahawk Cruise Missile (Submarine Combat Systems Integration Agent)
- SUBROC Weapon System (Design and In-Service Engineering Agent)

Submarine-Launched Torpedoes

- Torpedo Mk 48 Mods 1, 3 and 4 (Technical Direction and In-Service Engineering Agent)
- Advanced Capability (ADCAP) Torpedo Mk 48 (Technical Direction, Acquisition Engineering, and In-Service Engineering Agent)
- Torpedo Technology and Development
- Torpedo Propulsion Technology Block Manager
- Heavyweight Anti-Surface Warfare Torpedo (Technical Direction Agent)

Subsurface Target Simulators

- Mobile ASW Target Mk 30 (Technical Direction, Systems Integration, Design and Acquisition Engineering Agent)
- Advanced Mobile Acoustic Torpedo Target Mk 40 (Technical Direction, Acquisition Engineering, and In-Service Engineering Agent)
- Target EX 30
- Fast/Deep Target
- Expendable Mobile ASW Training Target Mk 39 (Technical Direction Agent, Acquisition Engineering Agent)
- Non-Acoustic Technology and Systems Programs (Technical Direction Agent and Lead Laboratory)
- Submarine Data Recording System (Technical Direction Agent)

Test and Evaluation Facility Development and Operation

- Undersea Range Technology and Range Development
- Mk 84 Fleet Tracking Pinger System (Technical Direction, Design, Systems Integration, and In-Service Engineering Agent)
- ASW System Evaluation and Certification (Consolidated Operability Tests, Weapon System Accuracy Trials, Torpedo Proficiency Firings, Training and Certification Program Firings, Consolidated ASW Readiness Tests, Submarine Acoustic Silencing Tests)
- Atlantic Undersea Test and Evaluation Center
- Southern California ASW Range

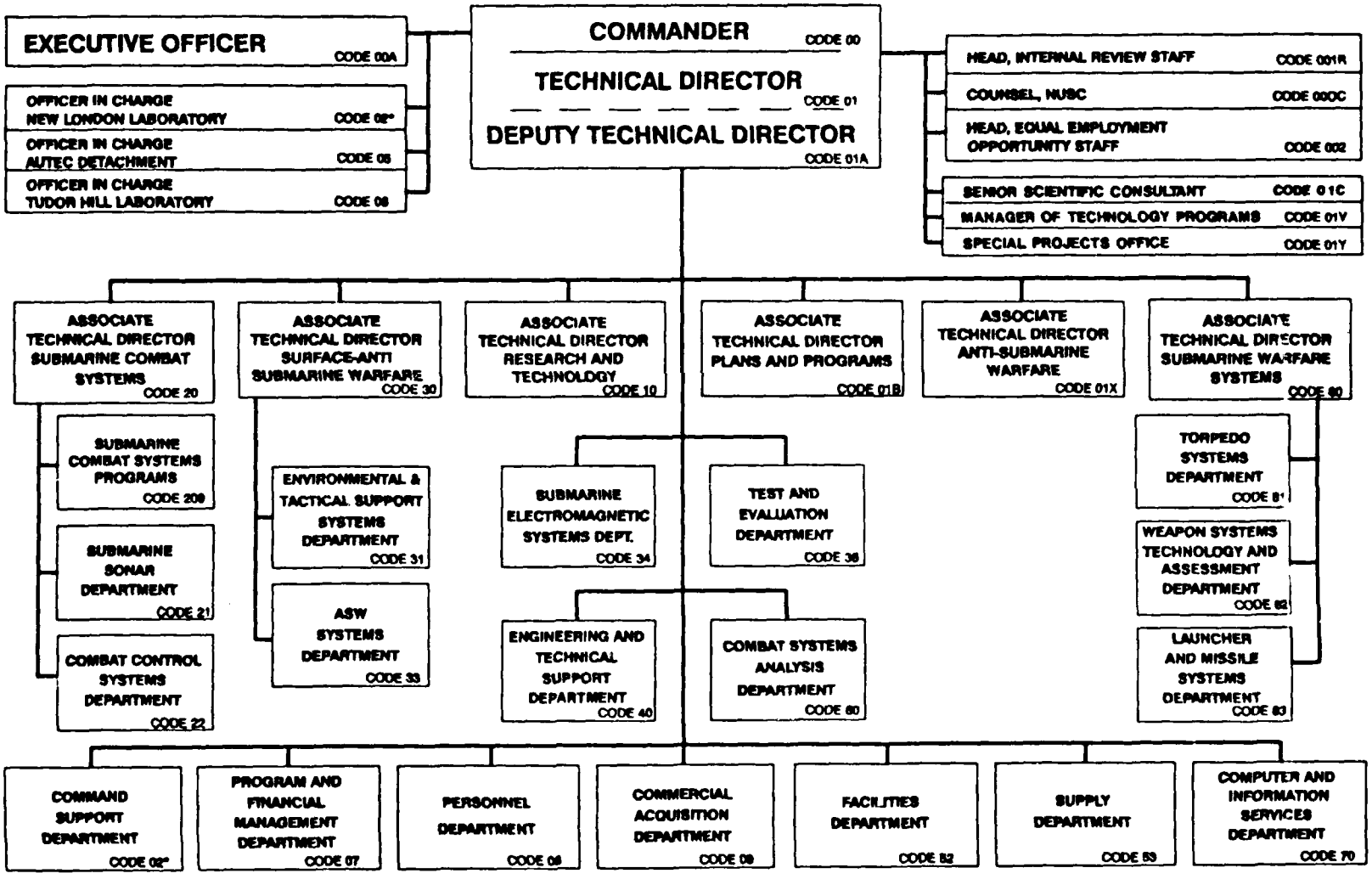
30 September 1987

NUSC MAJOR ACCOMPLISHMENTS

- The Combat Control System (CCS) Mk 1 Program C4.1, which will support Torpedo Mk 48 ADCAP and SSN 688 Vertical Launch System (VLS), successfully completed its factory acceptance test ahead of schedule.
- NUSC delivered the AN/BSY-1(V) Submarine Combat System on schedule to SSN 751.
- The AN/BSY-2 SSN 21 Submarine Combat System Prime Item Development Specification (PIDS), which provides fundamental design for this new combat system, was completed and delivered to industry for competitive contracting.
- NUSC supported the operational introduction of AN/SQQ-89 (Z1) on USS MOOSBRUGGER DD980, ANFQ-89 (V2) on USS CURTS FFG 38, and subsequent "best ever" surface ASW operations.
- The Mk 48 Advanced Capability (ADCAP) Torpedo progressed successfully through its initial operational evaluation by COMOPTEVFOR (Phase OT-IIA) and was approved for limited production.
- NUSC successfully demonstrated the first Sea Snake Towed Array.
- A submarine internal auxiliary launcher test facility for small device firing tests at simulated depth became operational.
- NUSC was assigned full responsibility for development, acquisition, and operational support tasks for the submarine TOMAHAWK capsule launch system.
- The NESP (Navy EHF Satellite Program) Submarine Terminal Equipment was integrated with a Type-8 Mod 3 Periscope at the NUSC Submarine EHF SATCOM Integration Facility, installed in USS BLUEBACK, and evaluated during pre-TECHEVAL at sea system trials.
- Systematic analysis of the OE-305 towed buoy antenna system identified key design deficiencies and their remedies which will be tested in FY88.
- The first submarine wide aperture array advanced development model installed on an SSN continued to demonstrate outstanding operational performance.
- The submarine TB-33 thin-line towed array has entered fleet use, bringing with it improved performance, increased reliability, and reduced cost.

30 September 1987

NUSC ORGANIZATION



*DOUBLE HATTED EFFECTIVE OCT 1987

30 September 1987

NUSC PERSONNEL DATA

Total On Board	Total Military	Total Civilians	FTP	TPTI	FTP Ungraded	FTP Graded
3779	94	3685	3601	84	228	3373

Breakdown of Civilian FTP Graded Personnel:

Scientists and Engineers (incl SES)	2,069
Administrative	381
Technicians	386
Other	765
Total	**3,601**

Budgeted Civilian End-Strength

FTP	3,498
Other	0
Total	**3,498**

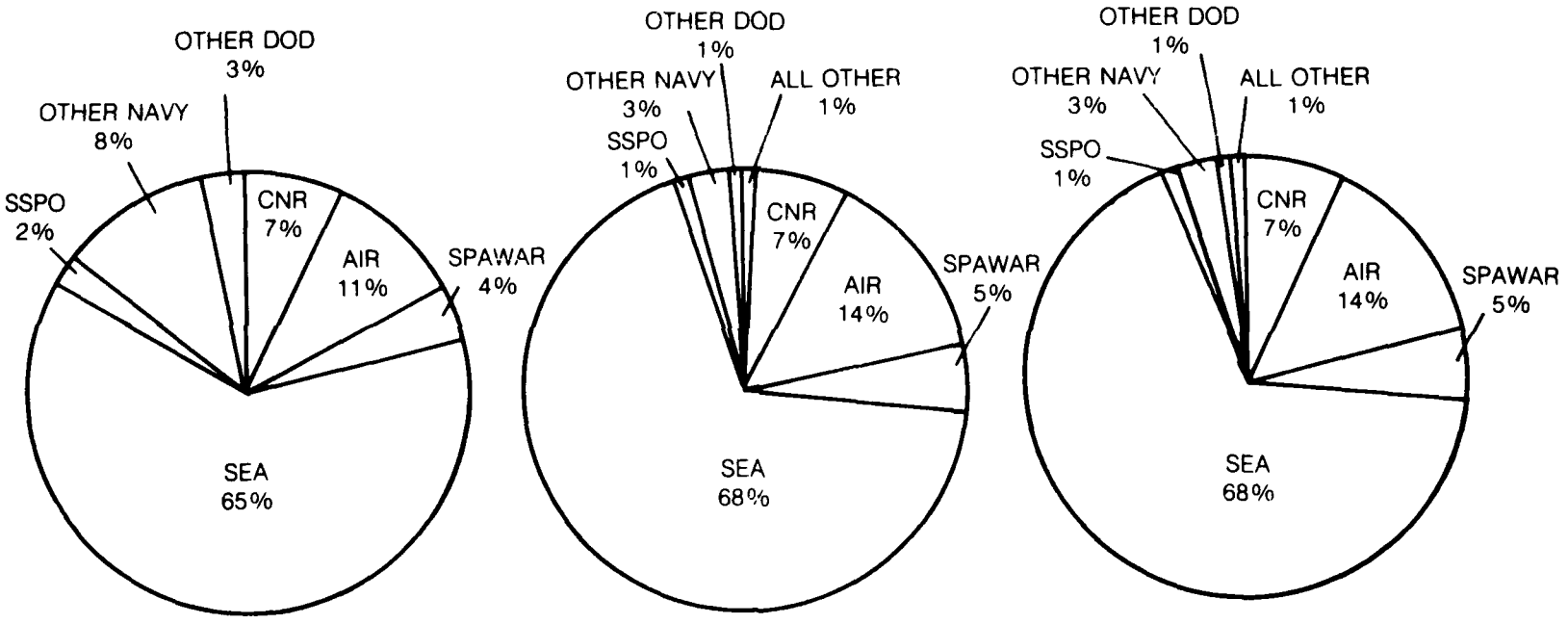
Military Personnel

	Allowance	On Board
Officer	37	33
Enlisted	72	61
Total	**109**	**94**

30 September 1987

NUSC FUNDING BY SPONSOR

*NOR



AIR — NAVAL AIR SYSTEMS COMMAND
CNR — CHIEF OF NAVAL RESEARCH
DOD — DEPARTMENT OF DEFENSE
NOR — NEW ORDERS RECEIVED

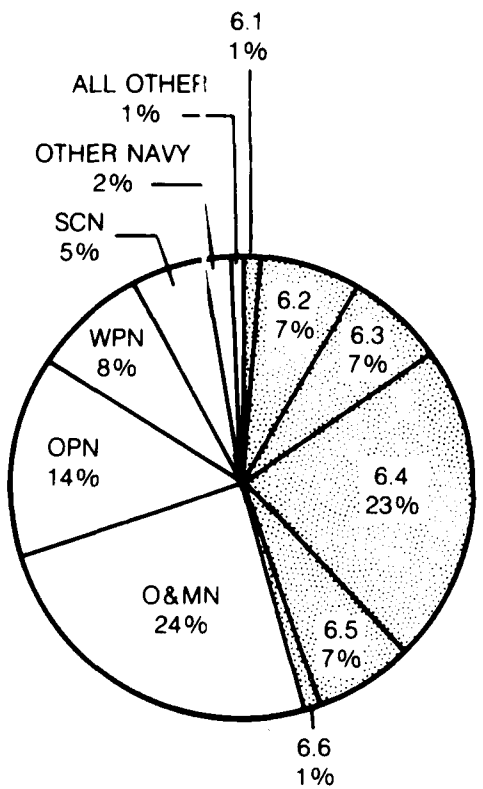
SEA — NAVAL SEA SYSTEMS COMMAND
SPAWAR — SPACE AND NAVAL WARFARE SYSTEMS COMMAND
SSPO — STRATEGIC SYSTEMS PROJECT OFFICE

*INCLUDES RCP's

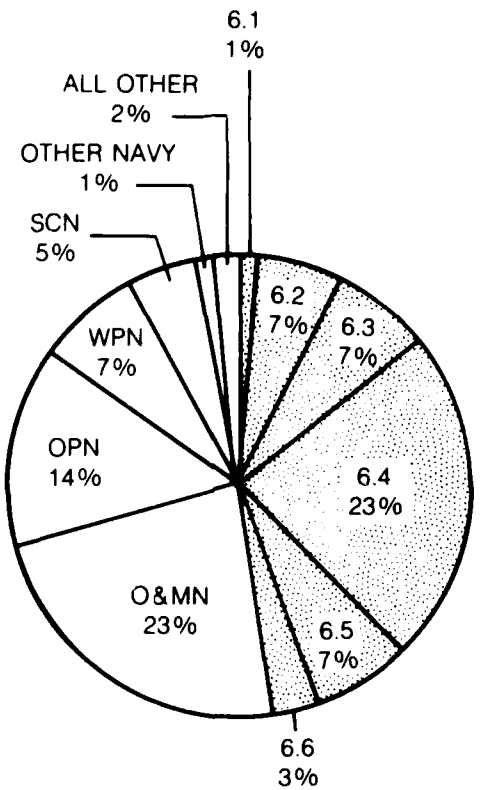
30 September 1987

NUSC FUNDING BY APPROPRIATION

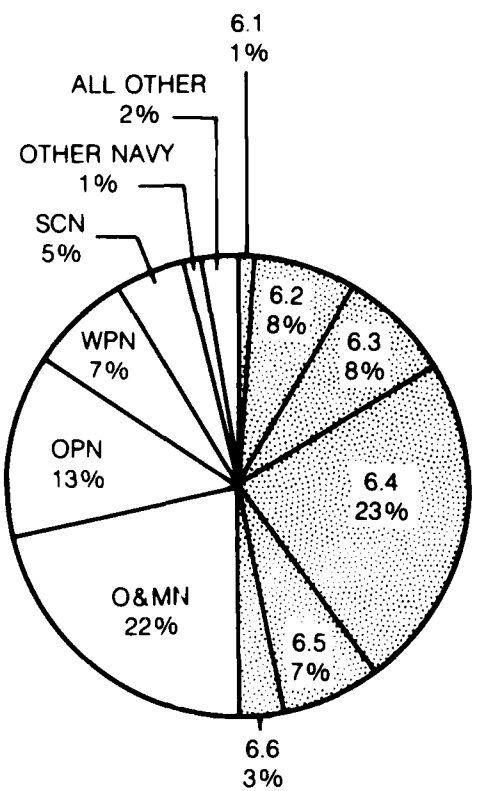
NOR



FY 87 ACTUAL
$597M



FY 88 PLANNED
$645M



FY 89 PLANNED
$697M

NOR — NEW ORDERS RECEIVED
O&MN — OPERATIONS & MAINTENANCE, NAVY
OPN — OTHER PROCUREMENT, NAVY

RDT&E — RESEARCH, DEVELOPMENT, TEST & EVALUATION
SCN — SHIPBUILDING & CONVERSION, NAVY
WPN — WEAPONS PROCUREMENT, NAVY

▒ = RDT&E

30 September 1987

NUSC FUNDING BY CATEGORY

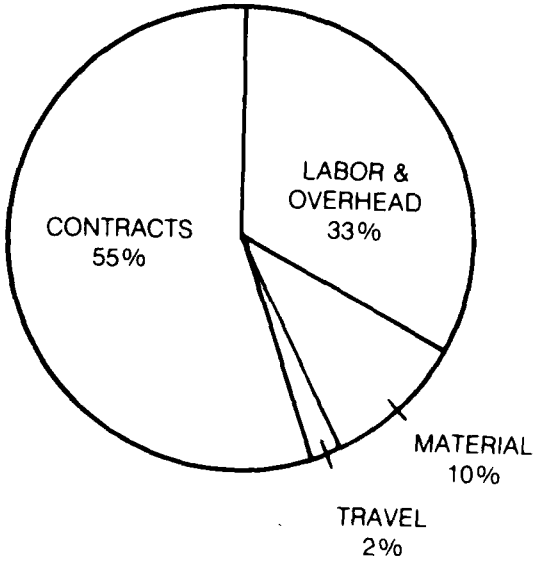
CATEGORIES & TYPES	FY87 ACTUAL			FY88 PLANNED			FY89 PLANNED		
	$M	%OF		$M	%OF		$M	%OF	
		RDT&E	TOTAL		RDT&E	TOTAL		RDT&E	TOTAL
RDT&E APPROPRIATION									
6.1 RESEARCH	4.1	1.5	0.7	6.5	2.1	1.0	7.0	2.0	1.0
6.2 EXPLORATORY DEVELOPMENT	40.5	14.8	6.8	45.2	14.6	7.0	55.8	16.0	8.0
6.3a ADVANCED TECHNOLOGY DEVELOPMENT	8.0	2.9	1.3	6.5	2.1	1.0	7.0	2.0	1.0
SUBTOTAL	52.6	19.2	8.8	58.2	18.8	9.0	69.8	20.0	10.0
6.3b ADVANCED DEVELOPMENT	33.0	12.0	5.5	38.7	12.5	6.0	48.8	14.0	7.0
6.4 ENGINEERING DEVELOPMENT	135.9	49.6	22.8	148.4	47.9	23.0	160.3	46.0	23.0
6.5 MANAGEMENT AND SUPPORT	44.0	16.0	7.4	45.2	14.6	7.0	48.8	14.0	7.0
6.6 OPERATIONAL SYSTEMS DEVELOPMENT	8.7	3.2	1.4	19.4	6.2	3.0	20.9	6.0	3.0
SUBTOTAL	221.6	80.8	37.1	251.7	81.2	39.0	278.8	80.0	40.0
TOTAL RDT&E	274.2	100.0	45.9	309.9	100.0	48.0	348.6	100.0	50.0
OTHER APPROPRIATIONS									
OPERATIONS & MAINTENANCE, NAVY (O&MN)	144.6		24.2	150 2		23.3	156.2		22.4
OTHER PROCUREMENT, NAVY (OPN)	84.7		14.2	87 9		13.6	91.4		13.1
WEAPONS PROCUREMENT, NAVY (WPN)	46.5		7.9	48.3		7.5	50.2		7.2
SHIPBUILDING & CONV, NAVY (SCN)	30.0		5.0	31.1		4.8	32.3		4.6
NAVY INDUSTRIAL FUNDS (NIF)	3.8		0.6	3.9		0.6	4.1		0.6
ALL OTHER	13.2		2.2	13.7		2.2	14.2		2.1
OTHER APPROPRIATION SUBTOTAL	322.8		54.1	335.1		52.0	348.4		50.0
TOTALS	597.0		100.0	645.0		100.0	697.0		100.0

NOR - NEW ORDERS RECEIVED

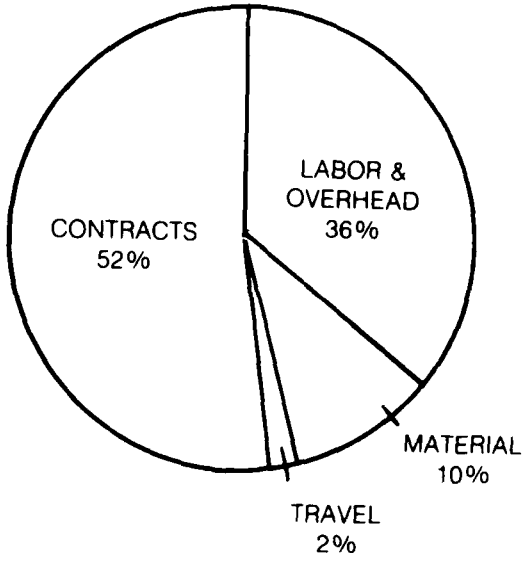
30 September 1987

NUSC DISTRIBUTION OF FUNDS

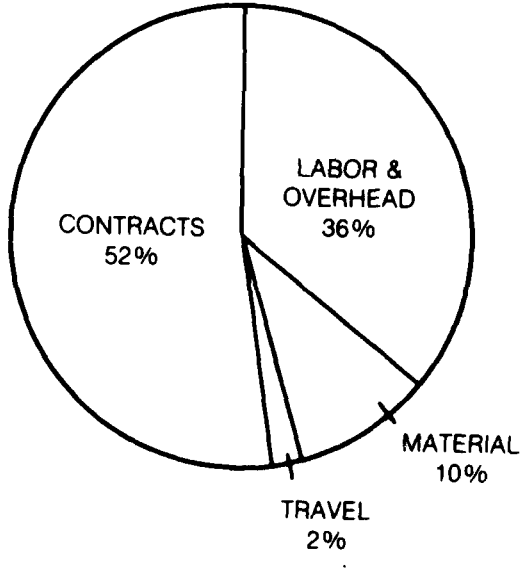
NOR



FY 87 ACTUAL
$597M



FY 88 PLANNED
$645M



FY 89 PLANNED
$697M

NOR — NEW ORDERS RECEIVED

30 September 1987

NUSC LEADERSHIP RESPONSIBILITIES

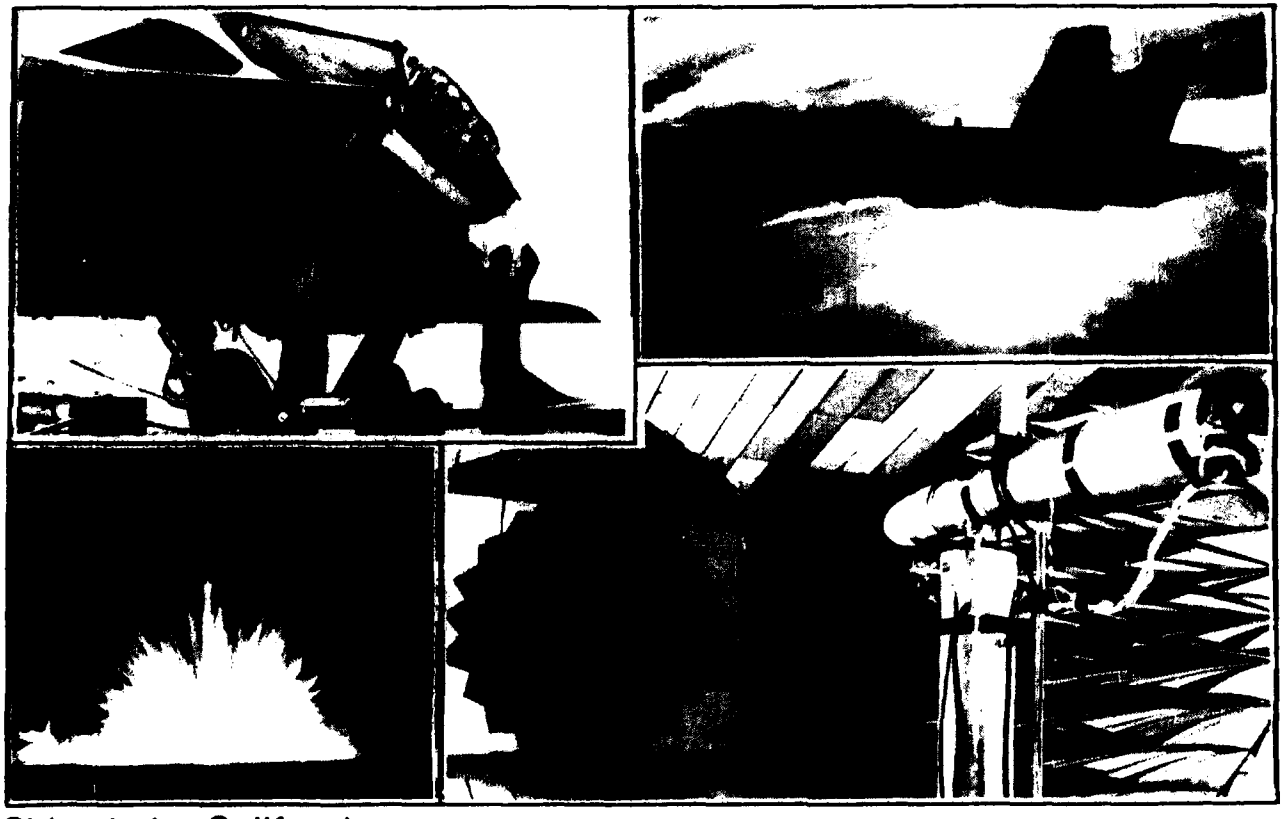
(NAVMATINST 5450.27C 1 August 1983)

- Submarine warfare analysis
- Submarine combat systems engineering and integration
- Submarine and surface ship acoustic reconnaissance and search systems (mobile sonar)
- Submarine electromagnetic/electro-optic reconnaissance and search systems
- Submarine electronic warfare and systems
- Submarine command and control systems
- Submarine combat control systems
- Submarine unique communications systems
- Submarine launchers (torpedo tube)
- Submarine launched torpedoes
- Submarine unique ASW tactical missile systems
- Underwater acoustics for system performance prediction
- Subsurface target simulators
- Undersea range development and operation

30 September 1987

NAVAL WEAPONS CENTER

BRIEF



China Lake, California
30 September 1987

NWC

J. A. Burt, Capt., U.S. Navy
Commander

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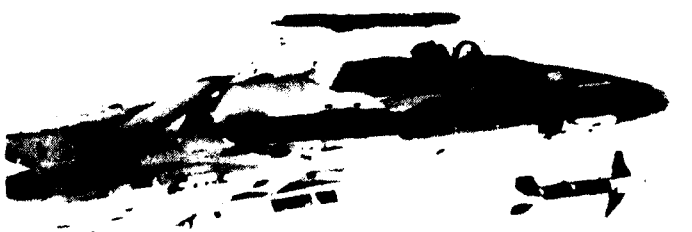
30 SEPTEMBER 1987

NWC

MISSION

To be the principal Navy research, development, test, and evaluation center for air warfare systems (except antisubmarine warfare systems) and missile weapon systems, and the national range/ facility for parachute test and evaluation.



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INTRODUCTION

The Naval Weapons Center, with headquarters, principal laboratories, and test ranges located about 150 miles north of Los Angeles, and additional test facilities located at Corona and near El Centro, Calif., is heavily involved in numerous Navy programs that support the Fleet and contribute to the Maritime Strategy. It is expected that most future air launched weaponry developments will be joint service. Liaison officers from other services—resident at NWC—actively participate in many of the development programs.

During the last 4 decades the Center has continued to expand the role it plays in the Nation's defense. Today NWC's mission is to be the principal Navy research, development, test, and evaluation center for air warfare systems (except antisubmarine warfare systems) and missile weapon systems, and the National range facility for parachute test and evaluation. The Center manages and conducts the complete weapon development process, from concept formulation through the entire lifetime of a weapon system, including Fleet and production support.

NWC has earned a worldwide reputation for ordnance such as the Sidewinder and Shrike family of missiles, free-fall weapons such as Rockeye and Gator, the antiradiation missile HARM, the TV-guided glide weapon Walleye, and rockets such as the 2.75-inch aircraft rocket. Equally important have been accomplishments in basic and applied research in aircraft systems software development, in direct support of Fleet operations, and in emerging technologies such as imaging sensors and artificial neural networks. Substantial management emphasis is placed on ensuring that the processes involved in converting an idea into hardware for the Fleet are responsive to service needs. Direct communication between experienced military officers and civilian scientists and engineers working side-by-side enhances the effectiveness of the Center's products.

NWC conducts exploratory development in air-launched weapons, missiles, and supporting technology. With unequaled experience in the development of weapons, unique range facilities, and extensive engineering capabilities, NWC is in a strong position to provide production support, product-assurance support, and in-service Fleet engineering support for its own products and those of others. NWC is the Navy's center of excellence in propulsion and warhead development for tactical missiles and is the predominant laboratory working on fuzes for the Navy's tactical guided missiles. NWC has experience in the fields of target acquisition, target identification/classification, and missile sensors/seekers (including infrared, radar, laser, and multimode) and is the DOD leader in the development of antiradiation missiles. The Center's foreign materiel exploitation (FME) program provides ongoing support to the defense intelligence community as well as providing unique design insights to NWC systems. In recent years, NWC has become the lead activity for system engineering and operational software support for avionics for the A-7E, A-6E, A-4M, AV-8B, F/A-18, and AH-1J/T aircraft. Because of unique T&E capabilities, NWC ranges and test facilities have been designated as part of the DOD-sponsored Joint Services Major Range and Test Facility Base.

As of 30 September 1987, the Center had 5,447 civilian employees. The number of military personnel on board was 503, excluding non-naval and tenant activity personnel. Estimated new obligational authority for FY 1988 is $700 million, with over one-half of all funding coming from the Naval Air Systems Command.

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MAJOR FACILITIES AND RESOURCES

The Naval Weapons Center is located in the upper Mojave Desert of California and consists of over a million acres of desert land with restricted airspace several times that size extending over the surrounding area. The land is typical of the arid region of the southwestern United States, and the terrain includes flat dry lakebeds, large dry washes, rugged mountainous areas, steep canyons, and numerous valleys of various sizes and contours. The weather is predominantly clear with very little precipitation and practically unlimited visibility throughout most of the year.

PROPERTY

Land acquired/withdrawn, acres	1,127,267
Buildings, square feet:	
RDT&E	2,240,910
Administrative	201,551
Other*	2,908,456
Acquisition costs, $ million:	
Real Property (Classes I and II)	269.0
Equipment (Classes III and IV)	149.9
Replacement costs	over $1.5 billion

* Includes housing and military support

MAJOR T&E FACILITIES

NWC has over 1,700 square miles of T&E ranges (and controlled airspace 10 times that size) with specialized instrumentation and facilities that make the applications of the NWC T&E complex almost unlimited. Many of NWC's T&E facilities are unique, and a significant investment is being made to maintain, upgrade, and modernize these facilities. T&E facilities improvement and modernization efforts include integrated range control, data processing, and upgrades to time, space, and position instrumentation on the North Range Complex and the EWTES Range; centralized and consolidated range management and support functions, modernization of ordnance T&E capabilities; enhanced control of drone aircraft targets; and expanded telemetry and communications capability. The Center's major T&E facilities include the following:

- **Air Operations Ranges**. These ranges include the *Air Weapons Range*, for operations against fixed and moving ground targets; *C Range*, for T&E of tactics and delivery techniques and for pilot training; and the *Military Target (Coso) Range*, for weapon delivery against actual and simulated military targets, including bridges, tunnels, surface-to-air missile (SAM) sites, convoys, armor, and gun sites.

- **Missile Firing Ranges**. The primary ranges in this complex are the *Guided Missile Range*, for T&E of air-and surface-launched systems and components; the *Small Missile Range*, for T&E of short-range missiles and evaluation of air-defense systems; and the *Vertical-Launch Range*, for firings from 0 to 90 degrees against low-altitude targets.

- **Missile Ballistics Range**. This range provides heavily instrumented facilities for controlled T&E of rockets and missiles, with emphasis on testing surface-launched ballistic and guided systems to gather data on launch and flight parameters.

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MAJOR FACILITIES AND RESOURCES (CONT'D)

- **Supersonic Track Facilities**. The Center operates two supersonic tracks: (1) the heavily instrumented *Supersonic Naval Ordnance Research Track* (SNORT) for tests requiring very high speeds, heavy payloads, long-duration runs, and controlled deceleration, and (2) the *Terminal and Exterior Ballistics Track* for tests in which the test item strikes a stationary target or is launched from the end of the track for free-flight testing.

- **Ordnance Systems Test Facilities**. This complex encompasses a diverse set of facilities for conducting live-ordnance T&E. Specific capabilities include *Explosive Test Facilities*, isolated sites for testing explosives and warheads, *Propulsion Test Facilities* for assessing the performance of airbreathing propulsion systems and the full range of rocket motors (from small tactical missiles to large strategic systems); and *Live-Ordnance Environmental Test Facilities* for testing all-up ordnance in any "stockpile-to-target" environment, from vibration to salt spray to fuel fire.

- **Electronic Warfare Threat Environment Simulation (EWTES) Facility**. Also known as Echo Range, EWTES provides the unique capability to test missile and countermeasures hardware, software, and tactics against simulated land-and sea-based electronic threats and radar systems.

- **Aircraft Survivability Range**. This range is used to test the survivability and vulnerability of aircraft and weapons to enemy weapons under simulated dynamic conditions.

- **Radar-Cross-Section Range**. The *Junction Ranch Radar-Cross-Section Range* is located in a remote area of the Center range complex. The range consists of two facilities: a horizontal range that allows state-of-the-art measurements of radar cross section at 700 and 4,000 feet, and a look-down range that provides the capability of measuring target cross section on or above a water background or tiltable ground plate.

- **Coso Tactical Range**. The Coso Military Target Range is used for development of air tactics and weapon delivery tactics. The range covers about 70 square miles of rough, mountainous terrain and allows Fleet pilot training in a realistic tactical environment.

- **Parachute Test Facilities**. These facilities support the Center's parachute RDT&E mission by providing a physiological response/human factors field-testing capability, a highly instrumented impact zone, a parachute drop tower, and a high-speed whirl tower. This capability supports aircraft emergency escape, midair recovery, and other systems involving parachutes and related subsystems and components.

- **Special-Purpose T&E Facilities**. NWC has numerous special T&E facilities, including the *Electro-Optical Field Laboratory* for evaluation of sensors, calibration of electro-optical equipment, and measurement of target signatures; and the *Aircraft-Carrier Conflagration-Control Test Facility* for T&E of firefighting and ordnance-protection devices and techniques for combating carrier-deck fires.

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MAJOR FACILITIES AND RESOURCES (CONT'D)

Construction was completed on three specialized facilities for T&E of Trident II strategic-missile rocket motors: the *Trident Motor Vertical Test Facility*, the *Trident Motor Horizontal Test Facility*, and the *Radiographic Inspection Facility*. These new facilities will enable NWC to support development and introduction of improved Trident II missile designs.

- **Airfield and Aircraft-Support Facilities**. *Armitage Field* is a fully equipped airfield that includes three major runways, three hangars, magazines and ordnance-handling facilities, and maintenance facilities. The Field provides aircraft, pilots, and other flying services needed to support NWC's mission. The Field also houses and supports specialized test facilities, shops, and avionics and computer facilities.

  Additionally, Armitage Field is the home of tenant squadron VX-5, an arm of the Operational Test and Evaluation Force. The presence of VX-5 provides the Center with valuable insight into Fleet needs and allows operational test personnel to become familiar with a system early in the development cycle, allowing much-needed military input and perspective on RDT&E programs.

MAJOR R&D FACILITIES

NWC maintains extensive facilities for the research, development, evaluation, and engineering support of weapon systems and related technologies. The Center's R&D laboratories and facilities are described below.

- **Michelson Laboratory**, a complex of various facilities, is equipped for basic and applied research in chemistry, physics, and related sciences; development of fire-control, guidance, and control systems; and hardware and software simulation. "The Lab" also includes several computer centers; modern industrial shops; a large photographic laboratory; and small workshops, conference rooms, and offices.

- **Propulsion Laboratories** are a complex of facilities that serve as the focal point of the Center's R&D and experimental production of solid and liquid propellants, rocket motors, explosives, and warheads.

- **Solid-State Research and Development Facility** is equipped for R&D of lasers, radar systems, electromagnetic interference, micro-electronics, and fuzes.

- **Lauritsen Laboratory** is dedicated to the research and development of lasers and related optical systems. The laboratory has special test facilities for realistic T&E of equipment designed to function at sea or in the air.

- **Encounter Simulation Laboratory**, a major indoor facility located at Corona, Calif., allows realistic encounter simulation with projected weapon targets using actual or

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MAJOR FACILITIES AND RESOURCES (CONT'D)

model fuze and sensor hardware. The facility provides high-quality data at low cost in tests against actual or simulated targets.

- **Weapons System Support Facilities (WSSF)** are aircraft-integration and simulation facilities used to integrate weapons and subsystems with the aircraft, validate avionics hardware and software to ensure that system requirements are met, and perform design engineering for computer systems and associated sensor and avionics equipment.

- **Simulation Laboratories** include anechoic chambers, and IR, imaging IR, and RF hardware-in-the-loop facilities. These facilities allow detailed flight simulation and testing against a variety of factors, including multiple targets and electronic countermeasures.

- **Engineering Laboratory** brings together several engineering functions including documentation, product assurance, interactive graphics, and soldering technology, providing a one-stop engineering capability for the Center's technical staff.

- **Antiradiation Laboratory** is the major Navy RF development facility for passive-type systems. This laboratory provides developmental support for antiradiation missile (ARM) seeker systems, aircraft-target identification and location systems, and electromagnetic compatibility support for developmental programs and the Fleet. The laboratory has three anechoic chambers, a multiple agile radar-target simulator, an ARM countermeasure test facility, and an electromagnetic-compatibility facility.

NWC HISTORY

In 1943, adequate facilities were needed for test and evaluation of rockets developed by the California Institute of Technology (CalTech). At the same time, the Navy also needed a new proving ground for all aviation ordnance. The Naval Ordnance Test Station (NOTS) was established in response to those needs in November 1943, forming the foundations of NWC. The mission of NOTS was defined in a letter by the Secretary of the Navy dated 8 November 1943: "...a station having for its primary function the research, development and testing of weapons, and having additional function of furnishing primary training in the use of such weapons."

The vast, sparsely populated desert around China Lake and Inyokern, with near-perfect flying weather year-round and practically unlimited visibility, proved an ideal location not only for T&E activities, but for a complete R&D establishment as well. The early Navy-CalTech partnership established a pattern of cooperative interaction between civilian scientists and experienced military personnel that, in the ensuing 4 decades, has made NWC one of the preeminent RDT&E institutions in the world.

Air-launched rockets, solid propellants, fire-control systems, and rocket and guided missile T&E were NOTS' primary areas of effort in the 1940s, and in the late 1940s, NOTS began research on fire-control systems that evolved into the concept of the Sidewinder guided missile. With the advent of the Korean conflict in the 1950s, NOTS rapidly expanded its work in rockets, missiles, torpedoes, and an array of guns, bombs, and fuzes. By the late 1950s research included such diverse fields as weather modification and satellite delivery systems.

American involvement in Vietnam in the 1960s quickened the tempo of activities at NOTS, and a new generation of "smart" bombs, cluster weapons, and antiradar missiles and night-attack systems was developed to meet Fleet needs. Electronic warfare received major attention, as did countermeasures and strategic systems.

In 1967 NOTS China Lake and the Pasadena Annex underwater-ordnance RDT&E facilities were separated. NOTS China Lake and the Naval Ordnance Laboratory, Corona, joined to form the Naval Weapons Center; in 1971 the Corona facilities were closed and their personnel and functions relocated to China Lake. The Center acquired the National Parachute Test Range function in 1979 and now serves as a National parachute RDT&E facility.

During the 1970s, electronic warfare, avionics hardware and software, and laser and optical technology became major areas of effort. Projects 21 and 2000 were initiated to provide the foundations for modernizing the Center's T&E facilities and other physical resources.

During the 1980s the Center has continued to carry out the complete weapon development process from basic and applied research through Fleet and production support. Building upon the expertise and experience of the past 40 years, NWC has continued to grow and expand, notably in the areas of fighter/attack weapon-system integration, avionics hardware and software and total combat system operational flight programs (OFPs) for most fighter and attack aircraft, embedded computers, and simulation systems. Major contributions include Sidewinder AIM-9L and -9M and AIM/RIM-7M, HARM AGM-88, Gator, the ACIMD advanced missile-technology demonstration, and SEAWARS. New facilities include the Engineering Building, Range Control Center, Weapons System Support Facilities, Trident II propulsion-test facilities, Junction Ranch Radar-Cross-Section Range, and the Navy Geothermal Plant One, Unit One on the Coso Range.

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NWC PROGRAM WORK

Program effort is directed toward air warfare systems and missile weapon systems. The full-spectrum activities include research; systems conceptualization, validation, and development; production support; product improvement; and Fleet in-service support. The efforts in major program areas are listed below.

MISSILES, ORDNANCE, AND RELATED SUBSYSTEMS

- **AIWS (Advanced Interdiction Weapon System)**. Serve as technical agent for NAVAIR for development of the system and conduct tests in support of a 2-year demonstration and validation program.
- **AMRAAM (Advanced Medium-Range Air-to-Air Missile) (AIM-120A)**. Provide technical support to the AMRAAM Joint System Program Office (JSPO) in the areas of systems engineering, target detection device (TDD)/fuzing, safety-arming systems, warhead, vulnerability, propulsion, F/A-18 aircraft interface, simulation modeling and analysis, test and analysis support, and life-cycle cost analysis. Emphasize areas where Navy-unique requirements exist. Coordinate efforts with NAVAIR PMA-268 and the AMRAAM JSPO.
- **Bigeye (BLU-80/B)**.* Technically manage design, development, and initial production jointly with the Army and the Air Force. Following initial production, transfer procurement responsibility to the Army as the single manager for conventional ammunition. Complete full-scale engineering development, validate and authenticate Level III technical documentation, and conduct Navy technical evaluation and operational evaluation.
- **Free-Fall Weapon Fuzing (FMU-140/B, DSU-30/B, FMU-139/B).*** Technically direct NWC contract to modify FMU-140/B dispenser proximity fuzes for Rockeye, Gator, and Bigeye dispensers. Incorporate electronic countermeasures and storage design improvements. Document, qualify, and release design to production. Technically direct NWC contractor to develop a proximity fuze to replace the Mk 43 TDD. Conduct environmental, flight, and electromagnetic compatibility tests to attain specification performance and schedule objectives. Document, qualify, and release design to production. Technically direct and provide production engineering support for NAVAIR-established production contract for FMU-139/B. Provide engineering support for First Article Acceptance Testing. Assist NAVAIR in developing a second source for the fuze.
- **Fuel Air Explosives (CATFAE, FAE) Technology**. Technically manage Navy FAE weapons research and development. Conduct design, development, and planning support of short-range rocket-propelled FAE device (CATFAE). Serve as lead design activity for the ordnance portion of CATFAE.
- **Gator (CBU-78/79)**. Place the Air Force kit modification unit into production and support the initial loading of Air Force production weapons at the Iowa Army Ammunition Plant. Serve as systems manager for introduction of the Navy Gator into production. Direct product improvement program on Navy and Air Force units.
- **General-Purpose Bombs**.* Serve as lead field activity for general-purpose bombs for NAVAIR, responsible for product improvements and new development. Establish a systems engineering approach for bombs and components; evaluate Mk 83 and Mk 82 with PBX-109 explosive; complete DSU-30 development; provide product improvement and engineering support for FMU-139; and evaluate inertially aided munition, cast bomb body, and Advanced Bomb Family.
- **HARM (High-Speed Antiradiation Missile) (AGM-88)**.* Provide technical management to NAVAIR, monitor contractor development and production efforts, support qualification of new sources, evaluate engineering changes, and provide software support for the AGM-88.
- **Harpoon (A/R/UGM-84)**. Serve as cognizant technical activity for missile subsystem less turbine engine and booster, and serve as design agent for ordnance package. Provide NAVAIR with technical/management support in system engineering, product improvement, guidance engineering, production support, ILS, product assurance, documentation support, and the Harpoon integrated test laboratory.

* Indicates lead laboratory responsibility

NWC PROGRAM WORK (CONT'D)

- **Laser-Guided Training Round (LGTR)**. Perform full-scale development; component, subsystem, and system development tests; and technical and operational testing. Provide production documentation, validation and authentication of system design, and low-rate initial production.

- **Maverick (Laser and IIR AGM-65E/F)**.* Serve as technical agent for NAVAIR to assist the Air Force in development of laser and IR versions of the Maverick weapon system for Navy use. Provide interface for aircraft integration, conduct captive flight tests, and support DT&E and OT&E.

- **OABMWS (Outer Air Battle Missile Weapon System (AAAM/ ASAM))**. Serve as lead R&D center for the demonstration and validation phase of the AAAM, and provide continuing technical support for the acquisition and design of AAAM. Provide technical teams to support the request for proposals (RFP) and source-selection activities.

- **Phoenix**.* Serve as lead laboratory for production engineering for prime and second-source contractors. Provide support to NAVAIR in technical management, engineering, product assurance, data/configuration, soldering technology, test equipment, ILS, and safety for the all-up round missile. Technically manage engineering development for fuzing components. Serve as design agent for target-detecting device, safety and arming device, booster, and fuze trigger device. Support NAVAIR in developing an alternate guidance unit for the AIM-54A.

- **PMS (Penguin Missile System)**. Provide technical and management assistance for development of the missile system. Establish NWC as technical data source; define system analysis tasks to establish expected missile performance baseline; develop an insensitive-munition warhead; and participate in technical reviews for missile guidance, control systems, rocket motor, and contractor-submitted documents.

- **RAM (Rolling Airframe Missile) (XRIM-116)**. Perform expanded role to include the guidance and control system and system engineering of the missile. Serve as acquisition engineering agent for NAVSEA. Continue responsibility as design agent for target detector, rocket motor, arming-firing device, contact-fuze triggering device, warhead, and safety-arming device. Provide technical support for subsystem components and system engineering, and provide general support for government-furnished material procurement and delivery.

- **Sea Lance (UUM-125)**. Serve as associate technical direction agency responsible for the weapon delivery vehicle in propulsion, airframe, avionics, retardation, capsule development, and software verification, validation, and certification.

- **Sidearm (AGM-122A)**.* Provide technical-management support to NAVAIR in design, test, configuration management, and production monitoring.

- **Sidewinder**. As cognizant design activity, provide technical engineering, configuration, and management support for the Sidewinder AIM-9 weapon systems, including assistance to NAVAIR to sustain production, qualification support of new and second sources, evaluation of producibility changes, and evaluation of modifications and product improvement during production.

  As cognizant technical activity for the Sidewinder AIM-9R, provide the technical engineering for developing a guidance section that will improve the AIM-9M head-on acquisition range in blue sky and background and allow better performance against countermeasures.

- **Skipper (AGM-123A)**.* Provide design, integration, and production support and design/development for follow-on work including Fiber-Optics Guided Skipper.

- **Sparrow (AIM/RIM-7F/M)**.* Assist NAVAIR program manager in production support of AIM-7 systems. Obtain contractor support services to maintain viable second source for production. Provide technical support for foreign military sales. Develop needs requirements for follow-on systems.

  For the AIM/RIM-7M PIP, develop an improved DSU-26/B fuze to provide needed changes for low-altitude target, fuze and missile-borne-computer interface, and large-target spectrum.

- **Standard Missile Ordnance Components**. Serve as design agent for all ordnance section components except warhead. Serve as technical direction agent in developing new booster and arm-fire device for SM-2 Block IV. Provide production and Fleet support for all Fleet-released items.

* Indicates lead laboratory responsibility

NWC PROGRAM WORK (CONT'D)

- **Tacit Rainbow (AGM-136A)**. As technical agent for NAVAIR, manage integration of WDU-30B warhead into the missile and provide direct support to the Joint Systems Program Office in evaluating the guidance system.

- **Tomahawk Cruise Missile (BGM-109)** * As principal support laboratory, provide technical assistance to Joint Cruise Missiles Program Office in developing and producing the antiship and land-attack versions of the cruise missile. Include missile engineering, EX-111 rocket motor, warheads, fuzes, guidance, inertial sensor assembly, T&E, Navy field activity coordination, capsule launch, and effectiveness studies.

- **Vertical Launch ASROC**. Serve as design agent for the VLA rocket motor and technical monitor for the thrust-vector-control system and digital autopilot/controller.

TACTICAL ELECTRONIC WARFARE AND COUNTERMEASURES

- **AN/ALR-45F/67 Radar Warning Receivers**. Provide technical management, integration with EW equipment, aircraft integration, and Fleet introduction support to NAVAIR for the AN/ALR-45F and AN/ALR-67.

- **ERASE (Electromagnetic Radiation Source Elimination)**.* Investigate and develop technology for antiradiation/defense-suppression targeting and missile guidance. Determine feasibility of multimode and multimission air-to-air and air-to-surface antiradiation homing systems.

- **EWTES (Electronic Warfare Threat Environment Simulation) Range**.* Develop threat simulation systems to evaluate airborne ECM and tactics. Operate and develop an integrated naval air defense system for an outdoor EW simulation threat facility.

- **FOLPEN (Foliage Penetration) Radar**. Serve as developing agency through the engineering development phase and transition to Air Force Special Projects Office (SPO) for initial production.

- **SEWS (Strike Electronic Warfare Simulator)**. Serve as technical management activity to design, develop, and implement a simulation facility to evaluate TACAIR electronic warfare systems.

SOFTWARE, TARGETING, AND SYSTEMS ENGINEERING AND INTEGRATION FOR FIGHTER AND ATTACK AIRCRAFT

- **A-4M Aircraft**.* Provide life-cycle software support for the angle-rate bombing system embedded weapon-delivery computer. Perform weapons and avionics engineering testing and Fleet problem investigations.

- **A-6 and A-7 Aircraft**.* Provide software and system engineering support. Design and test A-6E operational flight programs.

- **AV-8B Aircraft**. Provide avionics and embedded software support during Marine Corps aircraft production, and perform life-cycle software maintenance. Provide flight-test and instrumentation support during formal T&E. Develop software support capabilities for Marine Corps-developed trainers.

- **F/A-18 Aircraft**.* Assume design cognizance of major software operational flight programs. Provide life-cycle weapon system/software support, including acceptance, verification, and validation. Support development of avionics systems, weapon integration, and tactical software. Support trainers and foreign military sales. Provide configuration management of Fleet software.

- **Targeting Systems**. Develop and demonstrate targeting systems for tactical fighter/attack aircraft, missiles, and signal processing techniques to support targeting and target classification capabilities.

- **AH-1 Aircraft**. Provide engineering support for the AH-1 total system integration efforts.

* Indicates lead laboratory responsibility

NWC PROGRAM WORK (CONT'D)

CREW AND AIRCRAFT SURVIVABILITY AND PARACHUTE SYSTEMS

- ***Aircraft Survivability and Vulnerability*** Provide analysis, systems engineering, survivability enhancement technology, T&E, and implementation required to improve the survivability of naval aircraft and weapon systems.
- **Fleet Support Emergency Egress/Premeditated Parachute Systems** Provide basic design, logistic, and production and QA support to in-service equipment.
- **NACES (Navy Aircrew Common Ejection Seat) Program** * Qualify the recovery system for NACES and conduct escape system tests on the Supersonic Naval Ordnance Research Track
- **Recovery Subsystems**. Design, develop, and test emergency crew recovery systems and components associated with aircrew life support.
- **SEAWARS (Seawater-Activated Release System)** * Serve as acquisition agent and cognizant field activity for engineering and logistics.
- **Shuttle Personnel Recovery Program**. Design, test, and approve for use a Space Shuttle crew recovery system, and flight-test a crew escape system for NASA program.

OPERATIONS RESEARCH AND SYSTEMS ANALYSIS

- **Soviet Ship Vulnerability Program**. Develop and use antiship and antisubmarine weapon-lethality-assessment methodology, including detailed target descriptions and computer models of weapon effects.
- **WEPTAC (Weapons and Tactics Analysis Center)**. Provide interactive and iterative simulation support for development of weapon and sensor systems, development and examination of tactics, and Fleet interface with NWC.

TECHNOLOGY BASE

- Air-Launched Weaponry and Missile Support Technology Block Programs, including missile sensors/system processing, Soviet Ship Vulnerability Program, and technologies for fire control, guidance, airframes, fuzing, target signatures, warheads, and weapon propulsion.
- Marine Corps Aviation Exploratory Development Block Program
- Surface-launched fuze technology
- Explosives advanced development
- Explosives and fuze technologies
- Manufacturing technology
- Independent Research (IR) and Independent Exploratory Development (IED) Programs and Bid and Proposal discretionary tasks
- Ring laser gyro technology
- Ordnance cook-off improvement
- Strategic Defense Initiative
- Insensitive munitions
- Large-optics, rapid optical beam-steering, and optical-coating technologies

T&E FACILITIES AND SYSTEMS

- Full-Scale Aircraft Target (FSAT) Program development and production
- Range improvement and modernization
- Strategic program support
- Target control systems

FLEET SUPPORT

- AEWTR (Aircrew EW Training Ranges)
- ATSS (Aviation Training Support System)
- ECAMS (Enhanced Comprehensive Asset Management System)
- REWS (Range EW Simulator)

* Indicates lead laboratory responsibility

NWC

RECENT MAJOR ACCOMPLISHMENTS

AIRCRAFT/WEAPONS INTEGRATION AND AVIONICS

Development of operational flight program (OFP) 87X for the F/A-18 aircraft was completed, and the OFP became ready for OPEVAL. OFP 87X upgrades the aircraft mission computer, stores management, and displays. OFPs E/A/I 240 for the A-6E aircraft were completed; the OFPs integrate HARM, Harpoon 1C, IIR Maverick, and Laser Maverick with the aircraft, and contain other system upgrades.

DUAL-SPECTRUM SEEKER

A live missile firing demonstrated successful terminal guidance of a semiactive RF missile with a surrogate coaxial IR seeker. The firing also demonstrated appropriate boresight-error correction for the dual-spectrum air-to-air missile seeker.

GEOTHERMAL POWER PLANT

Navy Geothermal Plant One, Unit One, began operation on NWC's Coso Range. The 25-megawatt plant is the first to be built on Navy land; by 1990, power plants at Coso—built at no capital cost to the Navy—will be producing about 160 megawatts of Navy-owned electricity. NWC expects to realize savings of about $47 million in reduced energy costs in the first 10 years of operation of the first turbine alone.

HARM (HIGH-SPEED ANTIRADIATION MISSILE)

Prototype seekers and associated software for NWC's HARM Low-Cost Seeker design were received from each contractor and successfully tested in an anechoic chamber.

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RECENT MAJOR ACCOMPLISHMENTS (CONT'D)

INTEGRATED FIGHTER/ATTACK ADVANCED TARGETING DEMONSTRATION (FAATD)

A successful demonstration of a multisensor-fusion tracking system at the F-14/AWG-9 laboratory at Point Mugu provided 15 hours of real-time flight data, including simultaneous active radar, infrared search and track (IRST), electronic support measures (ESM), and range-tracking data. This system was transitioned to the F/A-18 aircraft and will be integrated into the operational flight program and hardware.

MODEL INSTALLATION PROGRAM (MIP)

The MIP seeks to explore and implement innovative approaches to managing military installations economically and efficiently while still retaining essential mission capabilities. To date, the NWC Commander has approved 85 Model Installation Program Initiatives (MIPIs) of which nearly 90% have been approved by higher authority for implementation at NWC. These MIPIs have delegated increased authority to the Commander, raised procurement thresholds, improve morale, and enhanced organizational productivity. One MIPI concerning Computing and Information Systems has resulted in annual cost-avoidance savings of $956,114 (20.7 man-year equivalents) and hard savings totaling $8.9 million over the next 3 years.

OUTER-AIR BATTLE MISSILE/ADVANCED AIR-TO-AIR MISSILE (OABM/AAAM)

Authorization for a new start for the AAAM was given; demonstration and validation of the long-range missile is scheduled to begin in FY 1988. NWC provided major technical support to the NAVAIR Program Manager during the phase leading to source selection.

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RECENT MAJOR ACCOMPLISHMENTS (CONT'D)

PHOENIX (AIM-54C)

The second-source contract for AIM-54C guidance sections was awarded after several years of effort; NWC provided the production drawing package, coordination, review, and continuing production support for both contractors.

SIDEARM AGM-122

Limited production was authorized for Sidearm, the small, self-defense antiradar missile for helicopters and close-air-support aircraft. NWC demonstrated in live firings a low-drag, extended-range improvement to the Sidearm.

SIDEWINDER AIM-9R

NWC completed the first full-scale engineering development (FSED) drawing-package update. The FSED contractor completed a preliminary design review on the packaging design, and long-lead release for initial engineering models was approved. NWC completed the first captive-carry flight with the AIM-9R integrated with an F/A-18 aircraft and demonstrated Sidewinder Expanded Acquisition Mode (SEAM) operation.

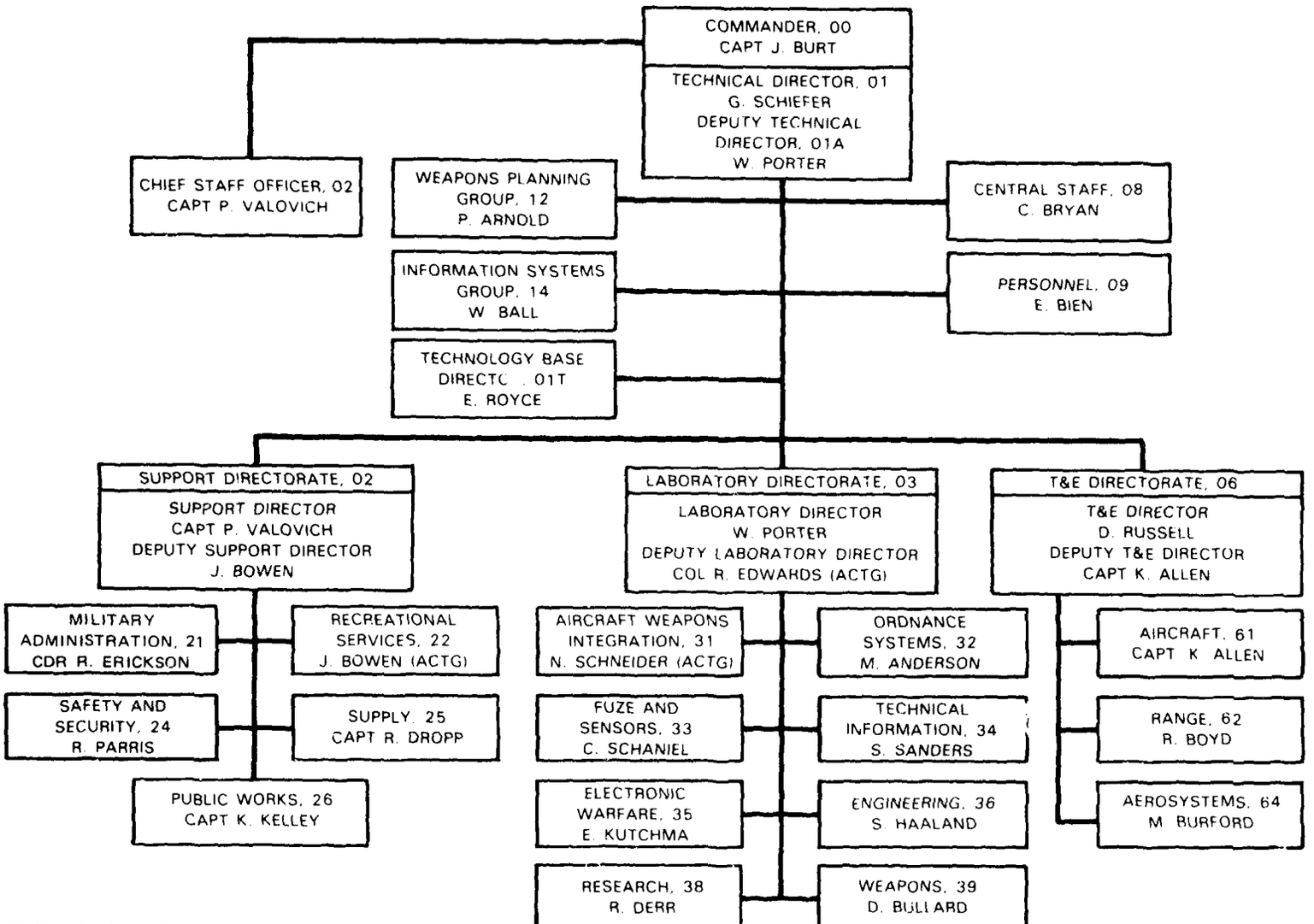
TRIDENT D5 ROCKET-MOTOR TEST PROGRAM

Vertical and horizontal test and radiographic inspection facilities were completed; initial firings with the individual and combined test systems were successful.

30 SEPTEMBER 1987

NWC NAVAL WEAPONS CENTER

BASIC STRUCTURE



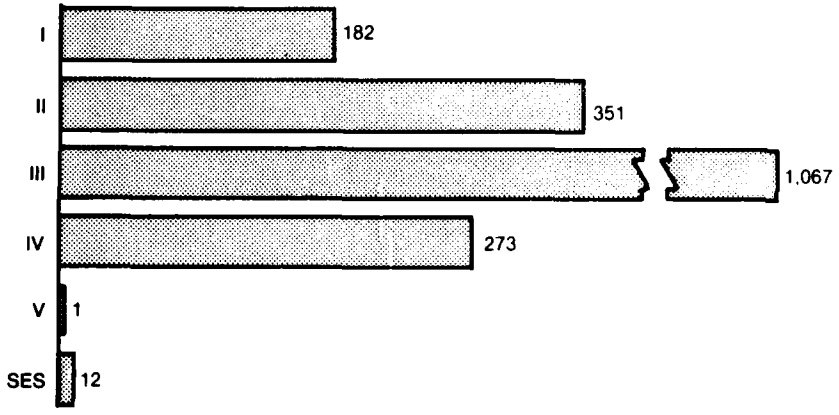
30 SEPTEMBER 1987

NWC NAVAL WEAPONS CENTER

PERSONNEL

TOTAL ON BOARD	TOTAL MILITARY	TOTAL CIVILIAN	FTP*	TPTI**	FTP* UNGRADED	FTP* GRADED
5,953	506	5,447	5,187	260	439	4,748

SCIENTISTS AND ENGINEERS BY DEMONSTRATION PROJECT LEVEL



NWC is engaged in a personnel Demonstration Project as authorized under Title VI of the Civil Service Reform Act (CSRA). The Demonstration Project waives the Classification Act, thereby eliminating the current General Schedule system in favor of new classification levels.

*FTP—Full-time permanent

**TPTI—Temporary, part-time, intermittent

ADMINISTRATIVE (CAMAS CODES 3000 AND 4000)	675
TECHNICIANS (CAMAS CODE 5000)	894
SCIENTISTS AND ENGINEERS (CAMAS CODE 2000)	1,886
OTHER (CAMAS CODES 6000 AND 7000)	1,293

ELECTRONIC ENG	603
MECHANICAL ENG	283
GENERAL ENG	134
AEROSPACE ENG	112
OTHER ENG	94
PHYSICIST	237
CHEMIST	77
MATHEMATICIAN AND STATISTICIAN	130
COMPUTER SCIENTIST	106
OTHER SCIENTIFIC	110

CIVILIAN END-STRENGTH:
5,159

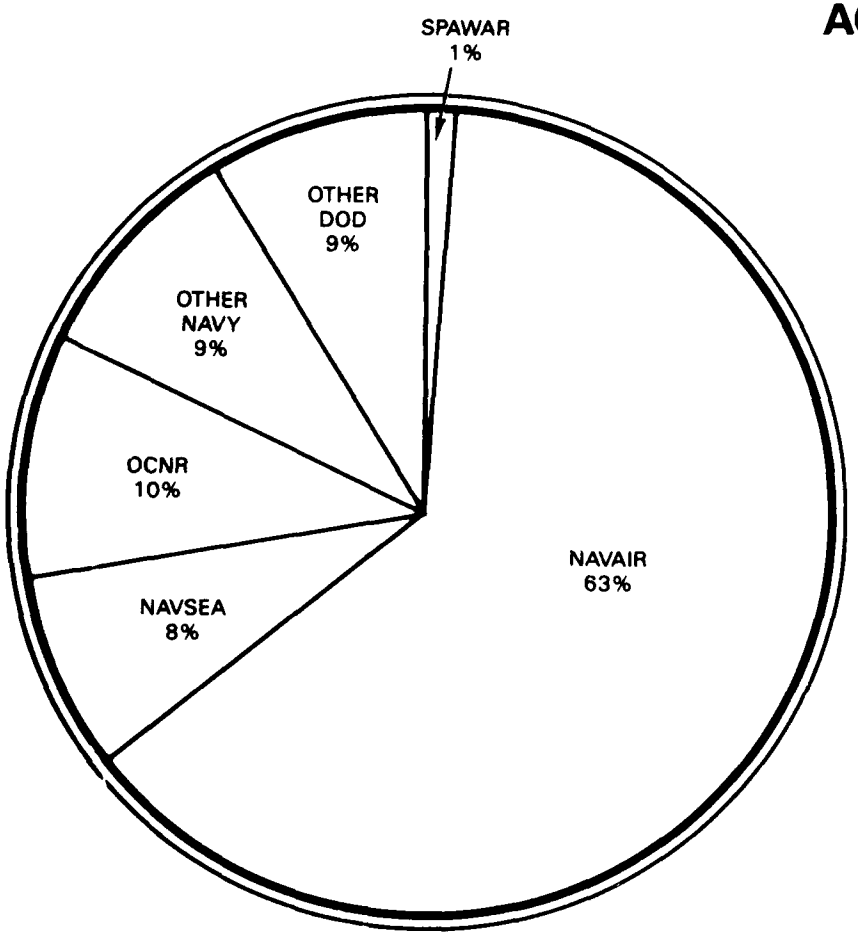
MILITARY ALLOWANCE:
OFFICER 56 ENLISTED 503

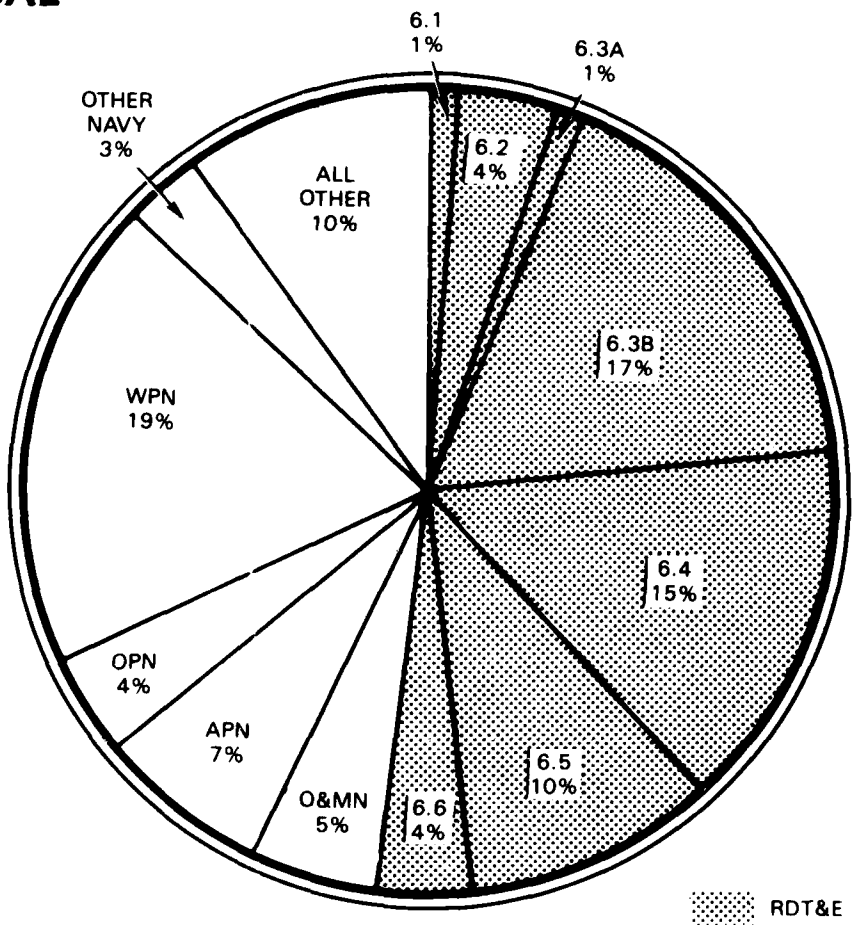
30 SEPTEMBER 1987

NWC

SOURCE OF FUNDS
FY 1987
ACTUAL

NEW ORDERS RECEIVED (NOR)
INCLUDE REQUESTS FOR
CONTRACTUAL PROCUREMENT





FUNDING BY SPONSOR

SPAWAR	SPACE AND NAVAL WARFARE SYSTEMS COMMAND
NAVAIR	NAVAL AIR SYSTEMS COMMAND
NAVSEA	NAVAL SEA SYSTEMS COMMAND
OCNR	CHIEF OF NAVAL RESEARCH

FUNDING BY APPROPRIATION

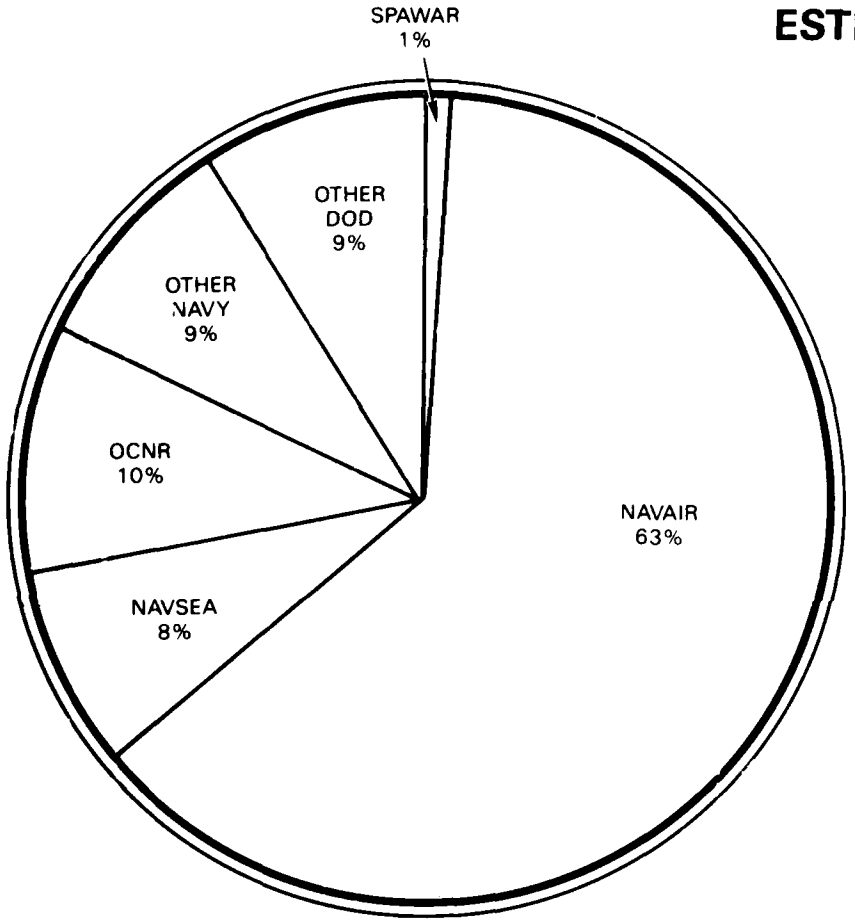
O&MN	OPERATIONS AND MAINTENANCE, NAVY
APN	AIRCRAFT PROCUREMENT, NAVY
OPN	OTHER PROCUREMENT, NAVY
WPN	WEAPONS PROCUREMENT, NAVY

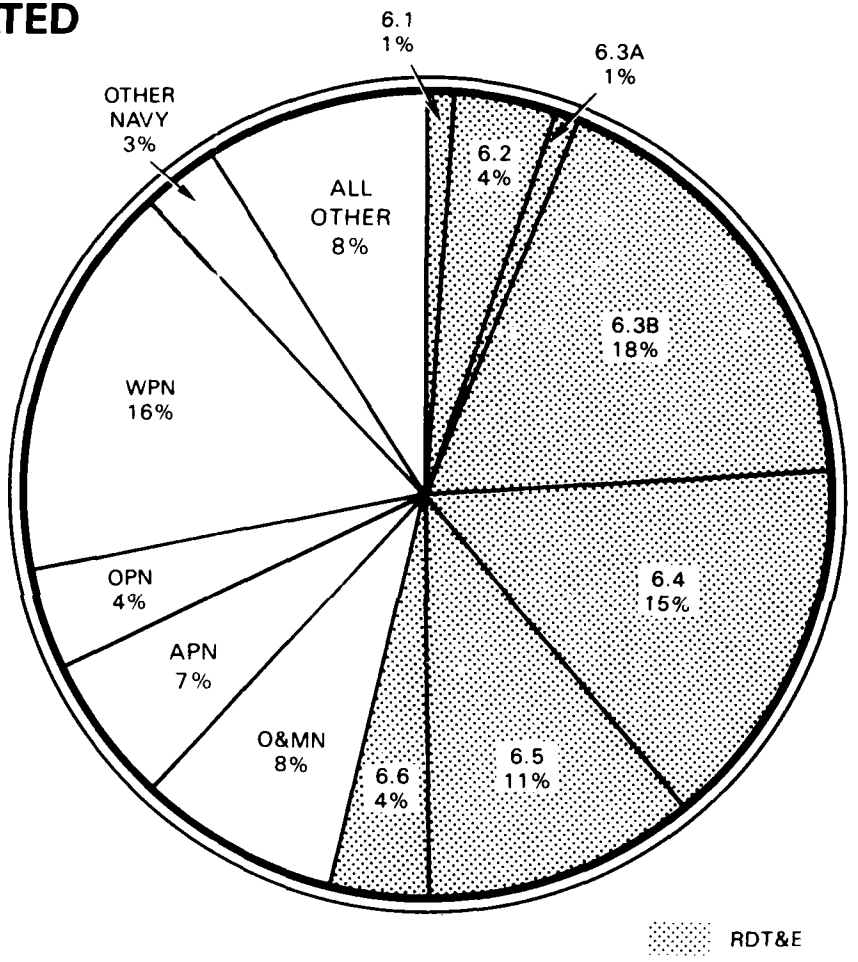
30 SEPTEMBER 1987

NWC

SOURCE OF FUNDS
FY 1988
ESTIMATED

NEW ORDERS RECEIVED (NOR)
INCLUDE REQUESTS FOR
CONTRACTUAL PROCUREMENT





FUNDING BY SPONSOR

SPAWAR	SPACE AND NAVAL WARFARE SYSTEMS COMMAND
NAVAIR	NAVAL AIR SYSTEMS COMMAND
NAVSEA	NAVAL SEA SYSTEMS COMMAND
OCNR	CHIEF OF NAVAL RESEARCH

FUNDING BY APPROPRIATION

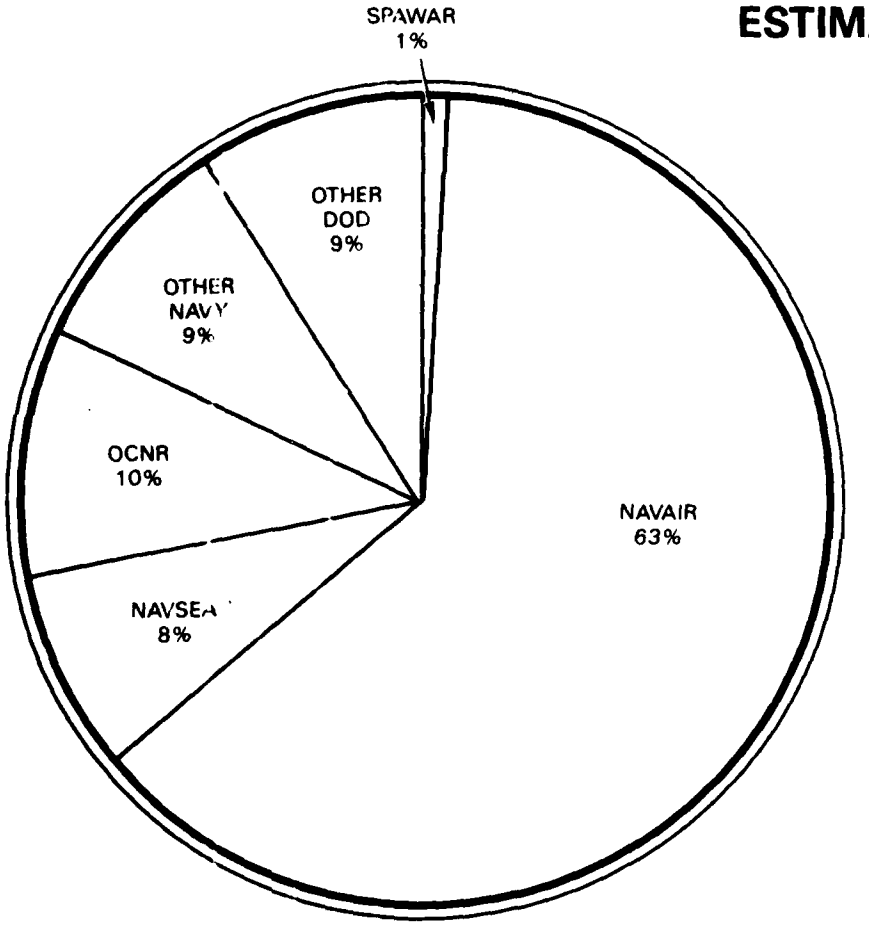
O&MN	OPERATIONS AND MAINTENANCE, NAVY
APN	AIRCRAFT PROCUREMENT, NAVY
OPN	OTHER PROCUREMENT, NAVY
WPN	WEAPONS PROCUREMENT, NAVY

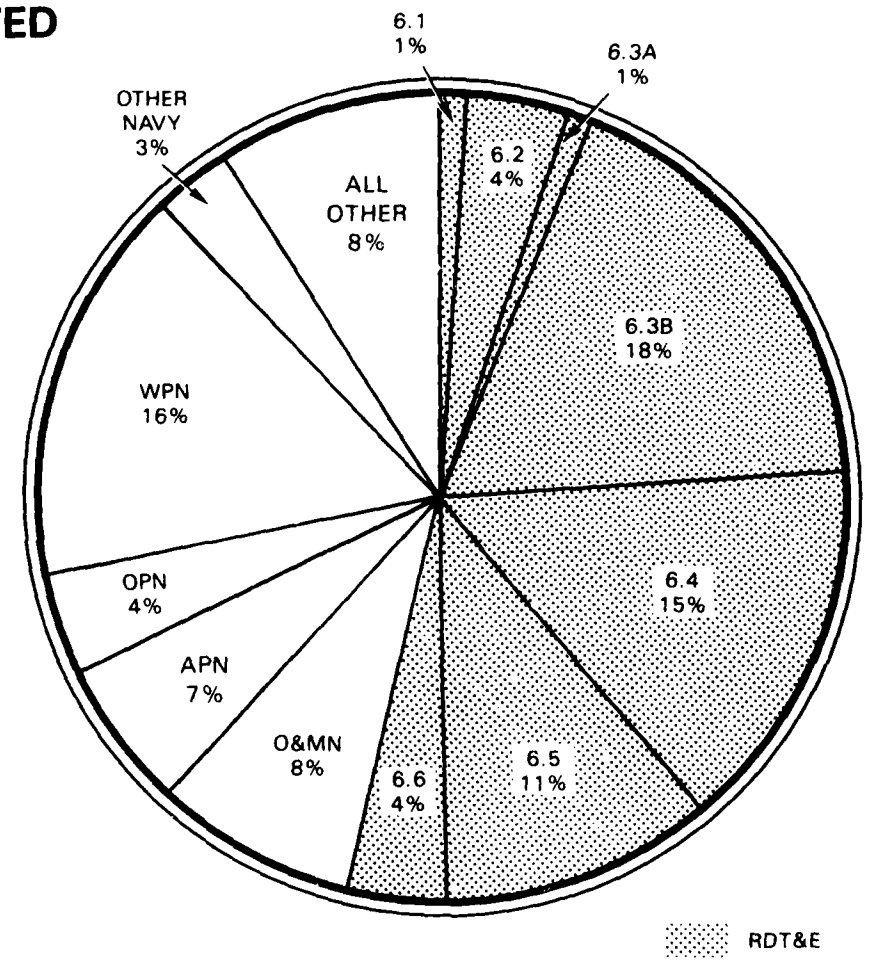
30 SEPTEMBER 1987

NWC

SOURCE OF FUNDS
FY 1989
ESTIMATED

NEW ORDERS RECEIVED (NOR)
INCLUDE REQUESTS FOR
CONTRACTUAL PROCUREMENT





FUNDING BY SPONSOR

SPAWAR	SPACE AND NAVAL WARFARE SYSTEMS COMMAND
NAVAIR	NAVAL AIR SYSTEMS COMMAND
NAVSEA	NAVAL SEA SYSTEMS COMMAND
OCNR	CHIEF OF NAVAL RESEARCH

FUNDING BY APPROPRIATION

O&MN	OPERATIONS AND MAINTENANCE, NAVY
APN	AIRCRAFT PROCUREMENT, NAVY
OPN	OTHER PROCUREMENT, NAVY
WPN	WEAPONS PROCUREMENT, NAVY

30 SEPTEMBER 1987

NWC

FUNDS BY CATEGORY & TYPE

NEW ORDERS RECEIVED (NOR)
INCLUDE REQUESTS FOR
CONTRACTUAL PROCUREMENT
$ IN MILLIONS

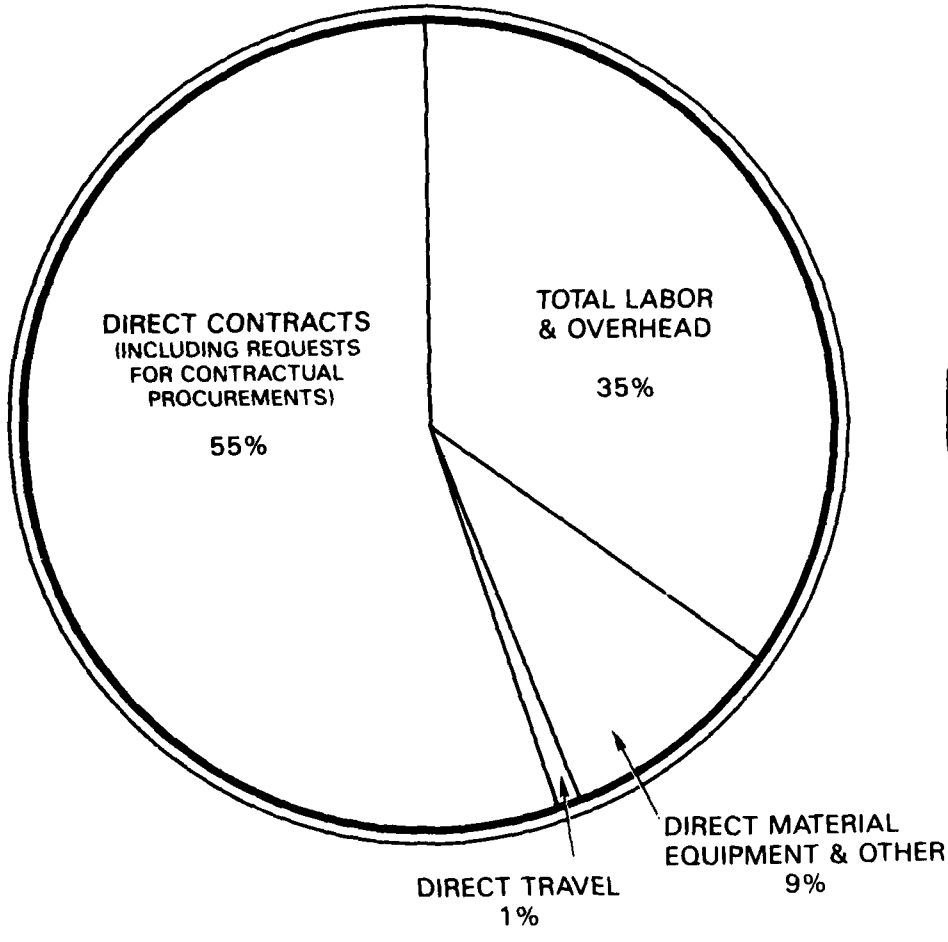
CATEGORIES AND TYPE		FY 1987			FY 1988			FY 1989		
		$M ACT.	% OF RDT&E	% OF TOTAL	$M EST.	% OF RDT&E	% OF TOTAL	$M EST.	% OF RDT&E	% OF TOTAL
RDT&E (CATEGORY)										
6.1	RESEARCH	8.1	2.1	1.1	8.1	2.2	1.2	8.0	2.1	1.2
6.2	EXPLORATORY DEVELOPMENT	30.8	8.0	4.2	30.8	8.1	4.4	31.0	8.2	4.4
6.3a	ADVANCED TECHNOLOGY DEVEL.	5.3	1.4	0.7	5.3	1.4	0.7	5.0	1.3	0.7
	SUB TOTAL	44.2	11.5	6.0	44.2	11.7	6.3	44.0	11.6	6.3
6.3b	ADVANCED DEVELOPMENT	127.7	33.2	17.2	127.7	33.7	18.3	128.0	33.8	18.3
6.4	ENGINEERING DEVELOPMENT	107.4	27.9	14.5	107.4	28.3	15.3	107.0	28.2	15.3
6.5	MANAGEMENT AND SUPPORT	72.9	18.9	9.8	72.9	19.2	10.4	73.0	19.3	10.4
6.6	OPERATIONAL SYSTEMS DEVEL.	32.6	8.5	4.4	27.1	7.1	3.9	27.0	7.1	3.8
	SUBTOTAL	340.6	88.5	45.9	335.1	88.3	47.9	335.0	88.4	47.8
	TOTAL RDT&E	384.8	100.0	51.9	379.3	100.0	54.2	379.0	100.0	54.1
(O&MN) OPER. & MAINT., NAVY		37.6		5.1	56.6		8.1	57.0		8.2
(APN) AIRCRAFT PROCUREMENT, NAVY		54.0		7.3	45.5		6.5	45.0		6.4
(OPN) OTHER PROCUREMENT, NAVY		32.7		4.4	24.7		3.5	25.0		3.6
(WPN) WEAPONS PROCUREMENT, NAVY		139.1		18.8	113.6		16.3	114.0		16.3
OTHER NAVY		24.0		3.2	24.0		3.4	24.0		3.4
ALL OTHER		69.0		9.3	56.0		8.0	56.0		8.0
	OTHER APPROPRIATION SUBTOTAL	356.4		48.1	320.4		45.8	321.0		45.9
	TOTALS	741.2		100.0	699.7		100.0	700.0		100.0

30 SEPTEMBER 1987

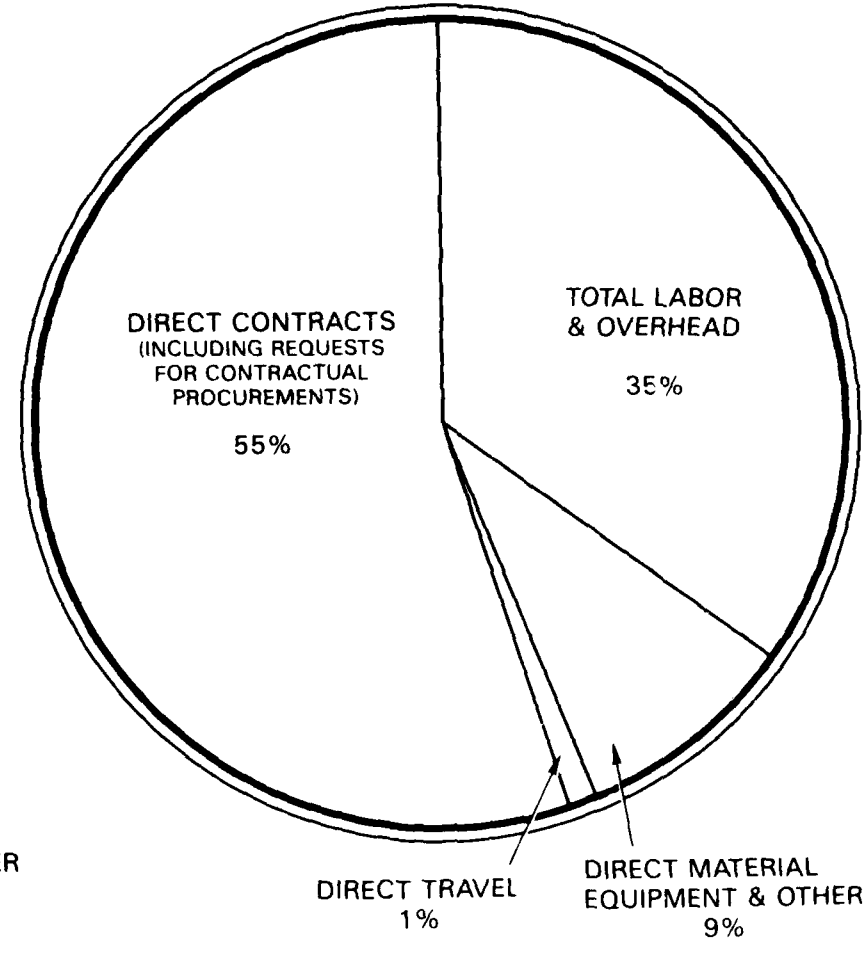
NWC

DISTRIBUTION OF FUNDS

FY 1988 ESTIMATED



FY 1989 ESTIMATED



30 SEPTEMBER 1987

NWC

LEADERSHIP ASSIGNMENTS

In conformance with NAVMAT Instruction 5450.27C, of 1 August 1983, NWC is responsible for Navy-wide leadership in:

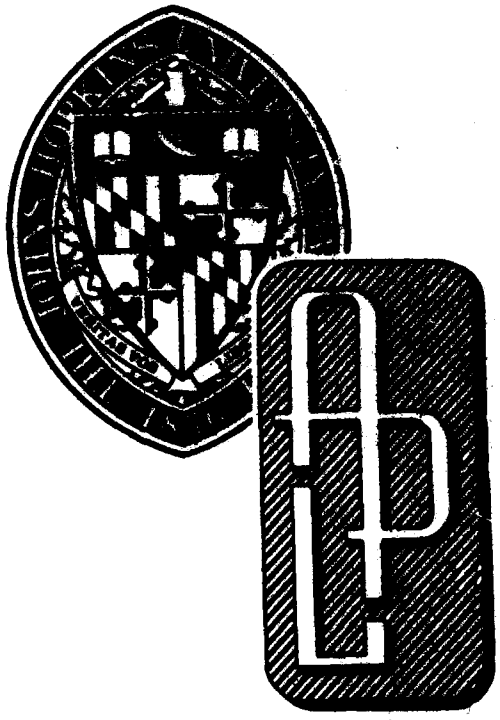
- Air warfare analysis (with the Naval Air Development Center (NADC)) (antiair, antisurface, and strike warfare)
- Air combat systems engineering and integration (with NADC)
- Missiles and missile subsystems
- Aircraft-launched free-fall weapons
- Aircraft electronic warfare
- Range development and operation (air-to-air, air-to-surface, and surface-to-air weapons; air electronic warfare; and parachute systems)
- Explosives (principally scale-up)
- Missile and free-fall weapon fuzing and warheads
- Aerial targets (full-scale)
- Aerodynamic deceleration (parachute) systems and components
- Aircraft and missile nonnuclear survivability and vulnerability

In addition to these major end products for which NWC has primary responsibility, the Center is also required to support SPAWAR laboratories, other Systems Commands, and other activities and services in a variety of product areas including aircraft, aircraft and weapons support systems, communications, aircrew life support, navigation, remotely piloted vehicles (RPVs), special warfare, strategic systems electromagnetic surveillance, shipboard launchers, and explosives application.

30 SEPTEMBER 1987

NWC Administrative Publication 377, published by the Technical Information Department. First printing, 150 copies.

Reviewed and approved for publication by S. E. Sanders, Head, Technical Information Department, NWC, 27 January 1988

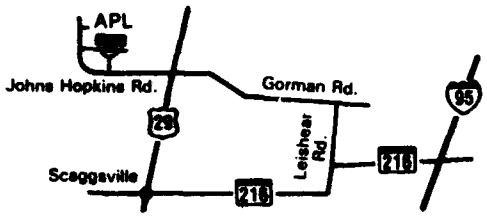


THE JOHNS HOPKINS UNIVERSITY
APPLIED PHYSICS LABORATORY

LAUREL, MARYLAND

BRIEF

THE JOHNS HOPKINS UNIVERSITY
APPLIED PHYSICS LABORATORY



Route 216 Detail

After leaving I-95 on Rte. 216 West, drive
1 mile to STOP light (Leishear Rd.), turn right;
1 mile to STOP sign (Gorman Rd.), turn left;
2 miles to APL (enroute, Gorman Rd. becomes Johns Hopkins Rd.).

30 September 1987

MISSION STATEMENT

The general purpose of The Johns Hopkins University can be stated as public service through education, research, and the application of knowledge to human affairs. As part of the University, the Applied Physics Laboratory shares this purpose through the application of advanced science and technology to the enhancement of the security of the United States of America and basic research to which its facilities can make an especially favorable contribution.

30 September 1987

INTRODUCTION

The Applied Physics Laboratory (APL) was organized in 1942 under the auspices of the Office of Scientific Research and Development to develop a projectile proximity fuze, which was urgently needed for antiaircraft defense. The Johns Hopkins University (JHU) undertook the management and operation of APL as a wartime obligation.

At the close of World War II, the administration and trustees of JHU, at the personal request of then Secretary of the Navy James Forrestal, agreed to continue the operation of APL to contribute to the country's future security. In late 1947 and early 1948, the JHU trustees examined the desirability of continuing sponsorship and operation of APL, and determined that it should be continued as a regular division of JHU.

Full responsibility and authority for the operation of APL is delegated by JHU to the Director of APL, who reports to the President of JHU. The APL Advisory Board meets periodically with the President of JHU to consider matters relating to the relationship between JHU and APL, including education and training programs, long-range planning, cooperation in research, and other academic activities. Meetings of the JHU Trustees Committee customarily include (by invitation) Navy officials with major interests in APL programs. These meetings provide opportunities for exchange of views on policy, plans, and current activity.

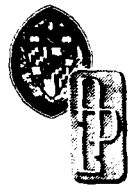
Current work at APL for the U.S. Navy falls into 19 major areas:

Ballistic missile systems test and evaluation
Fleet ballistic missile submarine security assessment
Gun systems
Missiles
High power radiation devices
Launchers
Fire control
Electronic warfare systems
Vehicles
Acoustic reconnaissance and search
Special sensors
Ocean surveillance
Command and control
Communications
Navigation
Integrated combat systems
Environmental description and effects prediction
Space systems and technology

In addition to providing large-scale effort in support of a large number of U.S. Navy missions, APL provides expertise in many specialized and divergent technological areas. Over the years, APL scientists and engineers have consistently advanced the state of the art in their respective areas.

APL operates primarily under a single contract with the Space and Naval Warfare Systems Command for all Department of Defense-sponsored activities and most other Federal Government activities. Policy guidance is provided by the Assistant Secretary of the Navy (Research, Engineering and Systems). Approximately 73% of the 1988 APL effort will be sponsored by the Navy.

30 September 1987



HISTORIC HIGHLIGHTS IN APL'S EVOLUTION

1942 APL was created to develop a radio proximity fuze for Fleet antiaircraft defense.

1943 *First proximity fuzes bring down two enemy planes in the Pacific.*

1945 APL participates in successful flight of world's first supersonic ramjet engine.

1947 APL Research Center established.

1948 APL participates in first successful flight of supersonic beam-riding missile. APL made a regular division of JHU.

1951 First successful flight of ramjet guided missile.

1954 APL's principal research facility established in Howard County, Maryland.

1956 Terrier operational aboard the USS *Boston*, world's first guided-missile ship.

1957 APL assigned major role in Polaris system evaluation.

1959 APL developed Talos long-range ramjet-propelled missile operational aboard USS *Galveston*.

1960 First successful launch of experimental navigation satellite, built by APL.

1961 APL-developed Tartar short-range rocket-propelled missile becomes operational.

1962 APL-built Anna, first geodetic research satellite, successful.

1963 APL-built navigation satellite was first satellite to be gravity-gradient stabilized in orbit.

1964 Beacon Explorer satellite developed by APL for NASA.

1965 Satellite navigation system developed by APL becomes operational aboard U.S. Navy submarines and surface units.

1966 APL-built Direct Measurement Explorers, GEOS I, and new navigation satellites successful.

1967 APL-built Dodge satellite sent into near-synchronous orbit; Dodge transmits first color pictures of the full earth.

1968 APL-built GEOS II and Lidos research satellites launched. Dodge satellite successfully gravity-gradient stabilized.

1969 APL begins urban mass transit studies and fire research program. Prototypes of three-dimensional X-ray device, prosthetic control system, and rechargeable heart pacer completed.

1970 APL participates in successful launch of Small Astronomy Satellite (SAS) into equatorial orbit. APL demonstrates (Aovanced Multifunction Array Radar (AMFAR).

30 September 1987

1971 Defense of the underwater fleet added as new APL mission. APL begins a study of air traffic control system radars. APL cited for its contributions to Navy pilots' safety.

1972 APL begins work on the ecological impact of power plant sites. APL participates in the successful launches of SAS-B and Triad (advanced navigation satellite).

1973 First patient implant of rechargeable long-lived cardiac pacemaker. APL-designed harbor traffic control system installed in San Francisco Bay.

1974 Successful testing on board USS *Norton Sound* of Aegis, advanced integrated surface ship weapons system developed by APL.

1975 APL particpates in the successful launching of GEOS-III, which demonstrates the feasibility of radar altimetry and satellite-to-satellite tracking, and SAS-C, which uses ultraprecise attitude control for investigation of "black holes."

1976 APL particpates in at-sea demonstration of advanced Standard Missile with new guidance system. APL participates in the design of an Ocean Thermal Energy Conversion (OTEC) ship.

1977 NASA Voyager 1 and 2 successfully launched to explore Saturn, Jupiter, Uranus, and Neptune; APL-developed Low Energy Charged Particle Experiment (LECP) on board for investigating the magnetospheres of those planets.

1978 APL-developed AN/SYS-1 automatic radar detection system is approved by the Navy for deployment aboard missile ships.

1979 APL-developed Magsat satellite begins mapping the earth's magnetic field.

1980 APL opens field office on the Chesapeake Bay to investigate the environmental impact from industrial and municipal facilities on aquatic life.

1981 First advanced navigation satellite (Nova) launched, carrying a new Disturbance Compensation System (Discos), developed by APL, that allows satellites to achieve a drag-free orbit

1982 USS *Ohio*, first Trident submarine, is deployed with U.S. Fleet, with APL particpating in its support.

1983 First Aegis ship, the cruiser USS *Ticonderoga*, commissioned, with APL participating in its development and support. APL participates in the development and launch of the Hilat satellite, which produces the first images of the Aurora Borealis made in full daylight, viewed from above.

1984 Active Magnetospheric Particle Tracer Explorers (AMPTE) complex space physics experiments successfully launched with three stacked satellites (a U.S. satellite built by APL, a German satellite, and a British satellite) which, in different orbits, investigated the earth's magnetosphere.

1985 Geosat satellite launched to precisely survey the world's ocean's for data to improve ocean navigation and for long-term oceanographic studies. APL develops the electronics for and performs system tests of the Hopkins Ultraviolet Telescope (HUT).

1986 APL-built Polar BEAR (Polar Beacon Experiment and Auroral Research) satellite launched to research means of improving radio communication over the polar regions.

1987 APL receives Presidential Commendation for its technical advice and the assembly of the science package for the Delta 180 spacebased defense system experiments.

HISTORY

FLEET ANTI-AIR DEFENSE

APL was organized in 1942 to develop and produce radio proximity fuzes and gun directors for Fleet defense. By 1943, production fuzes were being supplied to the Navy, and later to the Army and our Allies. By 1944, gun directors had been developed and were deployed.

In 1944, APL began their pioneering work in guided missile technology, with the aim of developing shipborne surface-to-air missiles for Fleet air defense. APL's work was mainly on the missiles themselves and on missile system compatibility. These efforts resulted in the Terrier missile becoming operational in 1956, and the Talos and Tartar missiles being deployed soon thereafter.

As more guided missile ships were commissioned, APL's responsibilities were expanded to include not only the missiles themselves, but also the associated fire-control equipment, continual upgrading of equipment, development of procedures and training, and ongoing development of new capabilities to meet the changing threat. The work performed at APL has continued with the Standard Missile series, and is involved with ongoing upgrades of the missile's operational capabilities.

APL has worked in the Aegis Program since its inception, and continues to develop new systems, hardware, and software to continually upgrade the Aegis system. New concepts and technologies are continually being developed at APL for surface ship combat systems of the future, beyond the Aegis era.

STRATEGIC MISSILE SYSTEMS

The expertise gained in those early developmental years of guided missile technology resulted in APL being chosen as technical evaluator and monitor of the Fleet Ballistic Missile (FBM) system, an effort that has continued to the present time. APL presently performs Demonstration and Shakedown Operations (DASO) testing on every new FBM submarine before it is put into service. The DASO program (and follow-on work) also pinpoints areas where improvements are needed, and demonstrates the effectiveness of the improvements after they are made. APL's evaluation of the submarine-based strategic missile system has continued to expand over the years, and includes the development and evaluation of new devices, such as air-launchable deep-ocean transponders, portable acoustic survey systems, and splash-activated deep-ocean transponders.

APL's expertise in the evaluation of missile system performance is also used in evaluations of the U.S. Army's medium-range Pershing II missile during test firings in the United States and in Europe.

SUBMARINE TECHNOLOGY

The Navy's SSBN Security Technology Program was created in 1969, with APL as the Principal Technical Agent. Those efforts led to the formation of the Submarine Technology Branch in 1972 as a part of the Strategic Systems Department. Then in 1978, the Submarine Technology Department was established, with the primary missions of the investigation of ocean science as it relates to submarine warfare, work

toward progressively better understanding of the signals generated by submarines and the corresponding noise fields, and work to develop a wide range of experimental sensors.

In 1976, at the request of the Navy, a program in nonacoustic antisubmarine warfare was begun. Then in the early 1980's, several new programs were added in areas such as tactical oceanography, the design of ranges for measurements of ship magnetic signatures, development of magnetic-signature computer models for minesweepers, acoustic towed-array technology, autonomous underwater vehicle technology, anomalous radar propagation, long-range active acoustic systems, and various nonacoustic and remote sensing technologies to detect submarines.

In all the submarine technology programs at APL, there is emphasis on heavily instrumented, full-scale, at-sea experiments to verify actual system performance and performance limits.

SATELLITE NAVIGATION

When Sputnik I was launched in 1957, APL scientists monitoring its radio beacon transmissions soon came forth with two important concepts. First, techniques were developed to determine a satellite's ephemeris via precise measurements of radio signals from the satellite. Second, a system concept was developed to use a satellite constellation for navigation and position location on or near the earth's surface. This latter concept resulted in APL's building the Navy Navigation Satellite System (NAVSAT; also known as Transit). Using Transit receiving equipment, a user can determine his position to within 150 meters with measurements made from a single pass, or to within 1 meter with multiple-satellite, multiple-pass measurements.

SATELLITE TECHNOLOGY AND SPACE SCIENCE

In the mid-1960's, APL built a number of small satellites for NASA for exploration of the ionosphere. Techniques were developed for a sophisticated means of satellite stabilization and very long-life operation.

To date, over 50 satellites have been designed, constructed, and tested by APL. Spacecraft sensors used have included infrared, visible light, and ultraviolet systems, as well as spaceborne radars and energetic particle detectors. APL's HILAT and Polar BEAR satellites observed daytime auroral displays. APL particle detectors on board the Voyager deep space probes confirmed APL's theory that charged-particle bombardment cause the blackened rings of Uranus. The GEOS radar altimeter, launched in 1985, continues to make precise measurements of the height of the ocean surface, as well as providing information for exact determination of the geoid. APL built one of the three satellites for the multinational Active Magnetospheric Particle Tracer Explorers (AMPTE) program, a program to expand knowledge of the interaction between the solar wind plasma and the earth's magnetosphere. A particle detector has been delivered to NASA for launch on the Galileo (Jupiter orbitor) mission in 1989. The Hopkins Ultraviolet Telescope, a collaborative effort of APL and JHU, has been delivered to NASA for use when space shuttle flights resume.

APL has become a leader in solar and planetary science, and has been a leader in investigating the principles governing the flow of energy between the earth and the sun. One important phase of that work is the study of the effects of charged-particle activity on radio propagation. APL scientists discovered the intense field-aligned currents that are major contributors to the aurora and to various phenomena of radio propagation.

Recently, APL was a major participant in the Delta-180 experiment, the first space experiment of the Strategic Defense Initiative (SDI) program. SDI work is continuing at APL.

APL provides technical guidance in propulsion and propulsion-related areas in the National Aerospace Program, and has developed a number of unique concepts in that work.

FACILITIES

- Propulsion Research Laboratory
- Cruise Missile Test Laboratory
- DSMAC Guidance Support Facility
- Combat Systems Evaluation Laboratory (CSEL)
- Warfare Analysis Laboratory (WAL)
- Thermal Imaging Laboratory
- Artificial Intelligence Research Laboratory
- Satellite Tracking Facility (STF)
- Ocean Data Acquisition Program (ODAP) Facilities
- Hydrodynamics Research Laboratory
- VHSIC Support Facility
- Guidance System Evaluation Laboratory (GSEL)
- Microwave Development Laboratory
- Embedded Computer System Engineering Laboratory (ECSEL)
- Strategic Simulation (STRATSIM) Development Facility
- Laser Photochemistry and Photophysics Laboratory
- Solid-State Research Laboratory
- U.S. AMPTE Science Data Center
- Sonar Evaluation Program Acoustic Recording System (SPARS) Laboratory
- Sonar Evaluation Program Analysis (SPAN) Laboratory
- Acoustic Processing Laboratory
- TOPEX Altimeter Ground Support Laboratory
- McClure Computer Center
- Space-Qualification Test Facility
- Time and Frequency Standard Laboratory
- SSD Computing Facility
- SATCOM-DSCS Facility

Land Owned/Leased	365 Acres
Buildings:	
RDT&E	649,103 sq. ft.
Administrative	166,082 sq. ft.
Other	24,484 sq. ft.
Acquisition Cost	
Real Property	$ 51 M
Equipment	$157 M

30 September 1987

PROGRAM WORK

APL is providing research, development, and/or support in the following major fields:

BALLISTIC MISSILE SYSTEMS

- Poseidon
- Trident I
- Trident II
- Pershing
- United Kingdom Systems
- Satrack

FBM SUBMARINE SECURITY

- SSBN Security Technology
- ASW Technology

GUN SYSTEMS

- Phalanx
- Deadeye Guided Projectile

ELECTRONIC WARFARE

- EF-111A
- EA-6B
- Joint Electronic Warfare

SPACE SYSTEMS

- TOPEX
- AMPTE
- Mars Observer
- Galileo
- Space Telescope
- Space Station
- Strategic Defense Initiative
- Janus
- Hilat
- Geosat
- N-ROSS

MISSILE SYSTEMS

- Standard Missile
- RAM
- AMRAAM
- Harpoon
- Tomahawk

INTEGRATED COMBAT SYSTEMS

- Aegis
- Tartar
- NATO Seasparrow
- Battle Group AAW
- E-2C
- Harpoon
- Tomahawk
- Terrier

C^3 SYSTEMS

- EHF Satcom
- C^3 Integration

TECHNOLOGY APPLICATIONS

- VHSIC Insertion
- Artificial Intelligence
- Materials Development

30 September 1987

MAJOR ACCOMPLISHMENTS, 1985-87

MISSILE SYSTEMS

As Technical Direction Agent for Tartar, APL oversaw the technical evaluation of the CGN/SM-2 system in June 1986 on USS *Virginia*. That upgrade uses the SM-2 (MR) missile, and the evaluation provided the first opportunity to fire SM-2 (MR) from a Tartar ship.

As part of the 1986 NAVSEA Risk Closure Program leading to the design of the next-generation Standard Missile (SM-2, Block IV), an extensive wind tunnel test program was conducted by APL in June 1986 using a 2/9-scale missile booster model.

Aerothermal testing was completed last winter on a half-scale, cooled metal radome developed by Aerojet Tech Systems under sponsorship of the Army Strategic Defense Command. The tests were conducted in the NASA/Langley Mach 7 free jet facility at 2500 psi and 3500°R. APL planned the tests and performed radar transmission measurements at 35 GHz. The tests demonstrated that this concept has potential use in hypersonic radar-guided missiles.

Extensive three-dimensional aerodynamic descriptions of the two prime missile and missile-booster aerodynamic designs for SM-2 Block IV have been developed at APL and have been provided to the Navy's airframe design authorities.

Approval for limited production of the Rolling Airframe Missile (RAM) was granted following flight tests. The basic concept of this ship defense missile, which is being developed jointly by the Navies of the United States and the Federal Republic of Germany, was originally put forward by APL. APL provides technical assistance to the Navy in RAM design and combat system engineering. During the recent flight tests, APL provided radio-frequency emitter units for the target drones, test design, test coordination, and analysis of the results of each event.

APL was involved with major upgrading of the Tomahawk Theater Mission Planning System. Significant improvements were developed by APL in digital scene-matching and in correlation scene selection and validation routines. The new capability was demonstrated at the Pacific Missile Test Center and will soon become fully operational in the Pacific and Atlantic Fleets. Computer-based programs were developed at APL to provide on-the-job training. APL developed algorithms for computation of dispense points for the Tomahawk Land-Attack Sub Munitions Dispensing Program; these were successfully demonstrated in development flights.

APL served as the lead laboratory for the Naval Air Systems Command in the preparation of the Development Options Paper for the Advanced Antiship Missile seeker guidance. This effort included participation of Navy laboratories, and was in response to tentative operational requirements from the Office of the Chief of Naval Operations.

The operational upgrade of a major upgrade of the Harpoon Anti-Ship Missile Seeker has been completed. APL acted as Technical Direction Agent for the Naval Air Systems Command.

STRATEGIC SYSTEMS

In June 1986, APL participated in the planning and conduct of the first Pershing II missile test firings to be performed with deployed units

and equipment, and also evaluated the collected data. The Pershing II system has now completed deployment and has achieved full operational capability.

In the Pershing Program, the first, second, and third Operational Tests have been completed, in which five Pershing II reduced-range missiles were launched at White Sands Missile Range, N.M., and 12 missiles were launched at Cape Canaveral. APL performed analyses of those tests.

APL assisted the Royal Navy in their 1986 flight tests of the newly remotored Polaris missiles to verify the reliability of the newly manufactured rocket motors. The new motors will extend the useful life of the older, but still effective, Polaris missiles.

The flat-pad flight test of the Trident II missile program began on schedule in January 1987, and four flights have taken place. Tracking of the Satrack and telemetry signals by the APL Satellite Tracking Facility was accomplished as planned on these missiles during the intervals of reentry body deployment.

The Operational Survivability Assessment Program (OSAP) for land-mobile missile systems for the Defense Nuclear Agency applies test and evaluation concepts, as well as APL's experience with Pershing weapon system survivability studies, to the two other major land-mobile missile systems deployed in Europe: the USAF Gryphon system and the Army's Lance system. For the Gryphon system, OSAP efforts consisted of the drafting of the Gryphon survivability study for review by the U.S. Air Force, Europe. For the Lance system, the OSAP Phase II Exercise Plan was prepared, three battalion-level field exercises were monitored, and the final version of the Lance Survivability Study was published.

APL is continuing tactical development testing for Fleet Ballistic Missile Submarines. A recent major test addressed the use of mobile countermeasures, evasion of antisubmarine aircraft, and counterattack operations. APL personnel continue their efforts in test plan development, test conduct, exercise reconstruction, and data analysis.

FLEET SUPPORT

The Air-Launchable Deep Ocean Transponder (ALDOT) development program was successfully completed in 1985, and the first units were operationally deployed in Pacific and Atlantic test range arrays in 1986. This system provides missile flight test impact scoring at significantly reduced costs (an estimated $15 M savings during the next 10 years). APL performed system development, integration, testing, and demonstration of ALDOT, and is coordinating and evaluating maintenance procedures.

An Arc Fault Detector System is being developed to protect shipboard electrical systems from damaging arcing faults. Operational Evaluation has been completed in a Navy ship. The system was proven to be both suitable and effective, and approval for production is expected shortly. APL will assist NAVSEA in the transition of this program from development to acquisition, and will continue to provide technical design for systems to protect newer classes of vessels.

APL, as the Navy's Test Director for the Oliver Hazard Perry class (FFG-7) of guided missile frigates, conducted development testing at the Guided Missile Frigate Combat System Test Site. The tests demonstrated the capabilities of the towed array sonar for passive location of submarines, and also provided data for evaluation of the integra-

tion of the LAMPS helicopter Electronic Support Measures (ESM) equipment with the combat system and measured the ability of weapons to acquire targets by using information from both the onboard (SLQ-32) and LAMPS ESM equipment.

APL assisted the Navy in the development, promulgation, and distribution of the Navy Command and Control (C^2) Plan, which provides consolidated policy and guidance for the fulfillment of recognized Navy C^2 requirements. The Navy C^2 Plan is the basis for the integration of programmatic and technical planning for future Navy C^2 systems to meet strategic and general-purpose forces requirements.

APL completed the development of a three-dimensional radar automatic detection and tracking system for the Spanish Navy's new aircraft carrier, *Principe de Austurias*. This task was sponsored by NAVSEA for the Foreign Military Sales Program.

In January 1987, APL completed the installation of a Sea Surface Surveillance System at the Pacific Missile Range Facility. The equipment was developed under the Laboratory's Automated Range Surveillance Program, which is sponsored by the Pacific Missile Test Center. It applies the latest techniques and technology to automatically create a complete and accurate picture of the location and track of all vehicles on the range, using surveillance radars located at separate sites.

In the Ocean Data Acquisition Program (ODAP), an upgrade of the Observer-I shipboard sensor and instrumentation system has been developed and installed on a Navy vessel and has completed at-sea checkout testing. The upgraded system incorporates improvements in sensor performance, navigation system capability, and real-time display utility, and is currently being exercised in limited operational scenarios.

One of a series of major ocean acoustics tests that will take place over a period of several years was carried out during the first half of 1987, using mobile and fixed acoustic elements. APL was the lead organization in this activity and was responsible for the coordination of a complex set of organizations, research vessels and operational ships, and submarine and aircraft units. The data are currently being analyzed.

Low-power, dynamic target-tracking tests were successfully completed at White Sands Missile Range, N.M., with the Navy's Sea Lite Beam Director. APL is providing technical assistance to the High-Energy Laser Program by developing advanced pointing and tracking concepts. Using special APL visible-laser position-sensor instrumentation, those tests demonstrated the successful application of the concepts.

Successful expendable drone (EXDRONE) test and evaluation flights were completed at the Naval Air Test Center, Patuxent River, Md. Final developmental and operational testing at White Sands Missile Range, N.M., began in August 1987.

SPACE SYSTEMS

APL's role in the National Aerospace Plane Program (NASP) will include design and testing of generic engine designs, fuel injector concepts, and devices to mitigate the effects of shock/boundary layer interactions in hypersonic inlets.

APL has continued its support of the AMPTE program, with all spacecraft ion releases now completed. An artificial comet was created in July 1985. The program has been highly successful. The three AMPTE satellites will continue to gather environmental data indefinitely.

In May 1987, the Oscar 13 satellite completed its twentieth year of continuous in-orbit operational service in the Navy Navigation Satellite System (NAVSAT), which provides Navy ships and other system users anywhere in the world with navigation fixes to an accuracy ranging from 150 meters (worst case) to 1 meter (best case). The present NNSS constellation includes Oscars 11, 20, 24, and 30 and the improved navigation satellites Nova-I and Nova-III. Development of NAVSAT began at APL in 1959.

ELECTRONIC WARFARE SYSTEMS

An increase in operational effectiveness of the U.S. Air Force EF-111A tactical jamming aircraft was successfully demonstrated by the 42nd Electronic Combat Squadron during the Power Hunter exercise in early 1987. The 42nd was the first to employ an automated electronic warfare Mission Data Generator developed by APL.

APL conducted a test and evaluation of the potential operational effectiveness of an electronic countermeasure system to protect tactical aircraft from guided missiles that use monopulse seekers. Subsequent to the report of the evaluation, a tri-service development program for the system was established.

A mobile data collection and analysis system developed by APL for the Joint Electronic Warfare Center (JEWC) has been deployed to three sites during operational test and evaluation of command, control, and communication systems, including the Joint Tactical Information Distribution System. It has allowed JEWC and Laboratory personnel to control test events and analyze results to a degree not previously feasible.

INFORMATION PROCESSING AND COMPUTER TECHNOLOGY

Development of the Hopkins Cellular Logic Processor has been completed as part of an Independent Research and Development project in advanced computing. The processor is based on a custom very-large-scale integration (VLSI) chip developed at JHU. The chip performs high-speed cellular logic on 256 × 256, single-bit image arrays. Twelve chips are used in a small coprocessor board for a personal computer, which achieves the effective performance of a Cray-sized machine in cellular logic computations.

The upgraded Analysis Data Processing System (ADPS) based on an IBM 3090-180E has been installed and is currently supporting the Strategic System Department's analysis efforts. The Cape Canaveral Field Office facility was modified for the new ADPS, and installation was completed in June 1987.

A custom VLSI 32-bit, high-performance microprocessor that directly executes programs written in the Forth programming language has been developed by APL. The processor architecture will meet the requirements of embedded computer systems in areas such as spacecraft control, interactive image analysis, real-time processing, and artificial intelligence applications. A patent disclosure has been filed, and negotiations to comercially license the design are under way.

The Mechanical Fabrication Group has modified a LeBlond Machining Center so that it can be programmed for continuous, unattended fabrication of complex metal parts. A saving of up to two-thirds (in manpower and fabrication time) can be achieved, as compared to conventional machining operations.

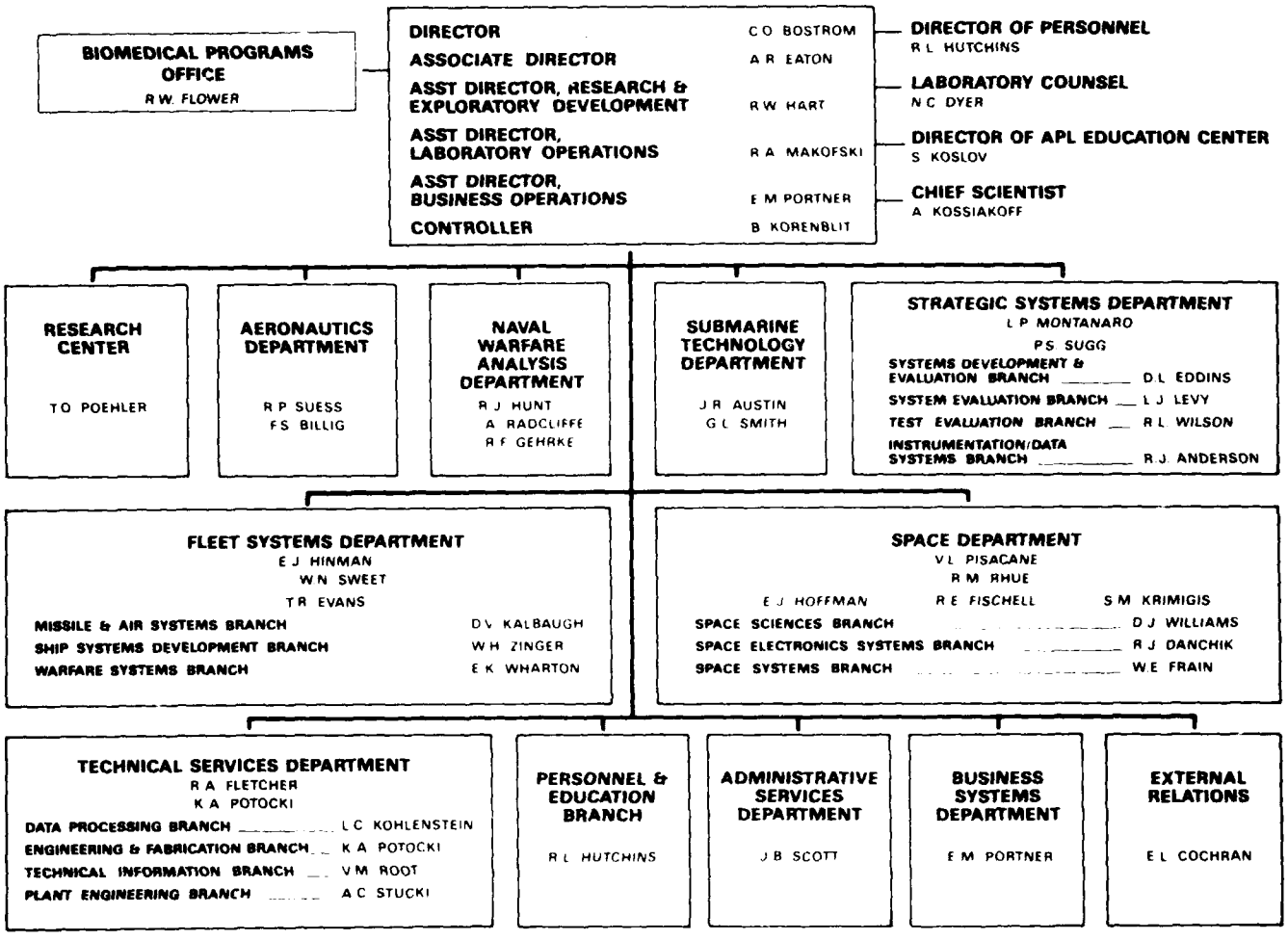
BASIC RESEARCH

The APL Research Center's investigations of nonthermal damage to ocular tissues caused by microwave radiation show that pulsed microwave fields may induce an increase in iris vascular permeability, and may damage the corneal endothelium. These results have significance with respect to damage mechanisms, and suggest that pulsed microwaves may interact with and alter the natural function of other biological barriers throughout the body and, as a consequence, could have therapeutic value.

Collaborative research by the Research Center and the Microelectrics Group on surface and materials investigations in microelectronics has continued to provide information (not previously available) that establishes a scientific basis for improved device performance and reliability. APL has been requested by the Navy to conduct a workshop on Microelectronic Materials, Analysis, and Reliability.

As part of the Research Center's Aeronomy Program, APL participated in a major field test of the nuclear winter hypothesis in the Angeles National Forest, Calif., in December 1986 and June 1987.

ORGANIZATION



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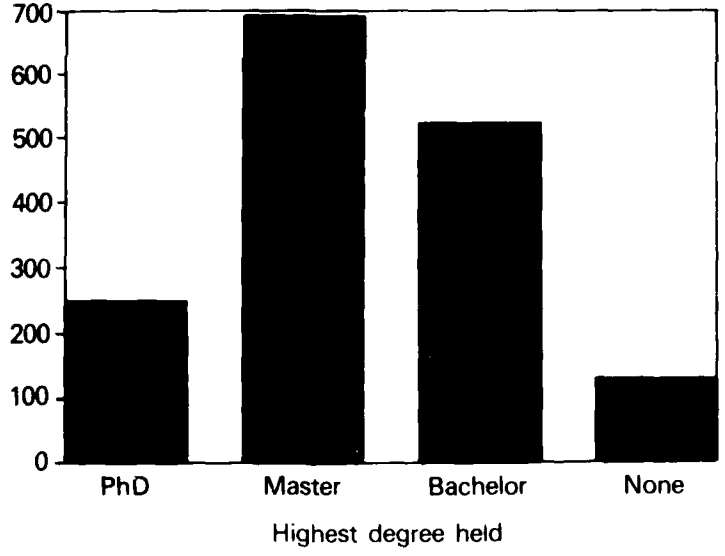
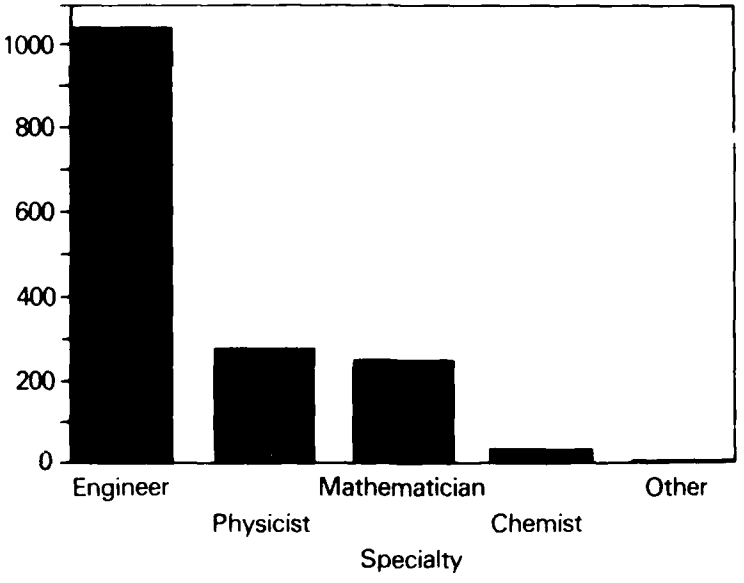
PERSONNEL DATA

Total Personnel On Board	
On Board	2816
Scientists and engineers	1621
Administrative (Professionals)	169
Support	1026

Scientists and Engineers



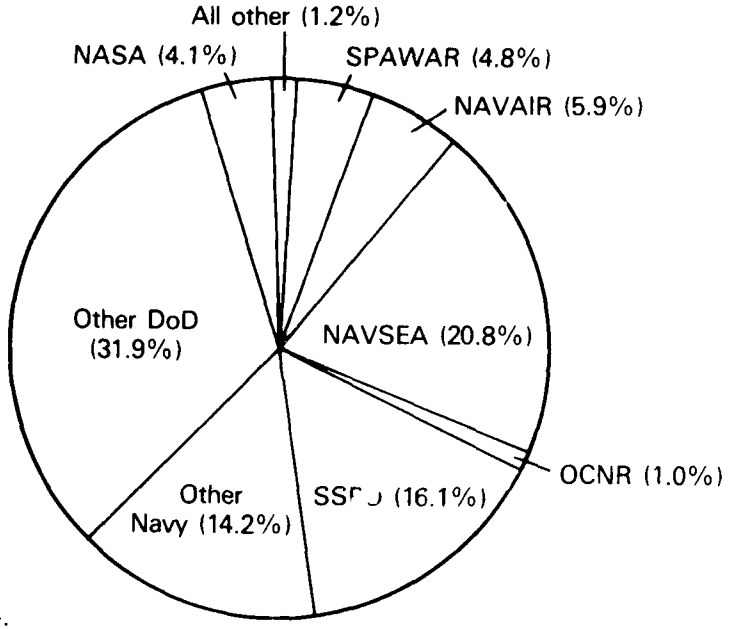


30 September 1987

SOURCE OF FUNDS

FY 1987 — ACTUAL $359.1 M

FUNDING BY SPONSOR

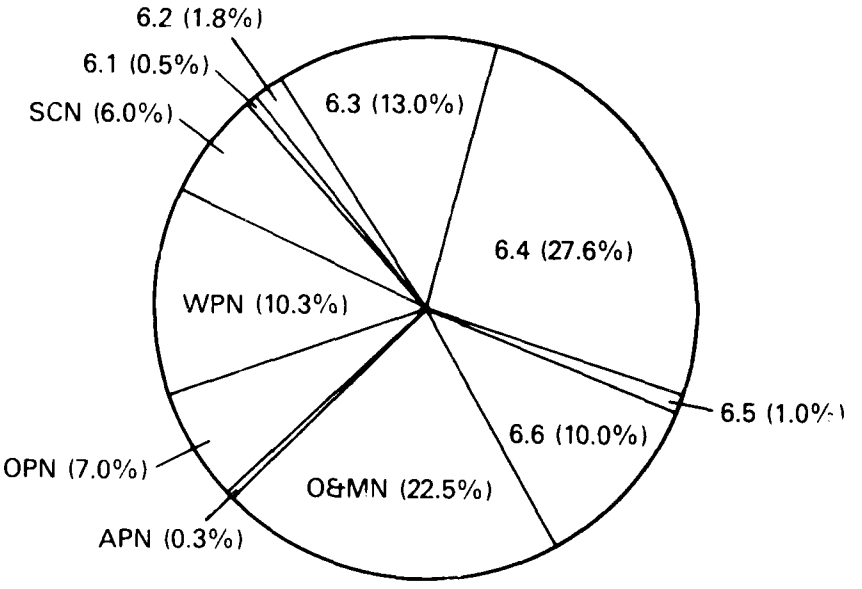


KEY:

SPAWAR	Space and Naval Warfare Systems Command
NAVAIR	Naval Air Systems Command
NAVSEA	Naval Sea Systems Command
OCNR	Office Chief of naval Research
SSPO	Strategic Systems Project Office
NASA	National Aeronautics and Space Administration

30 September 1987

NAVY FUNDING BY APPROPRIATION



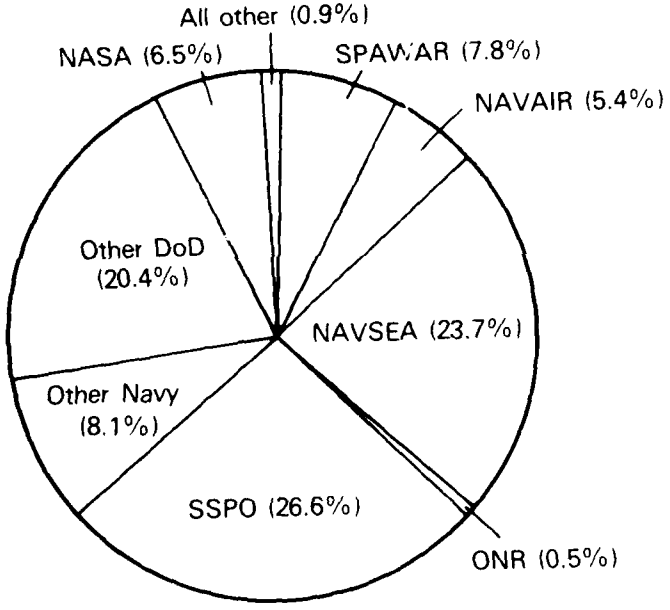
KEY:

O&MN	Operations and Maintenance, Navy
APN	Aircraft Procurement, Navy
OPN	Other Procurement, Navy
WPN	Weapons Procurement, Navy
SCN	Shipbuilding and Conversion, Navy

SOURCE OF FUNDS

FY 1988 — ESTIMATED $352.9 M

FUNDING BY SPONSOR



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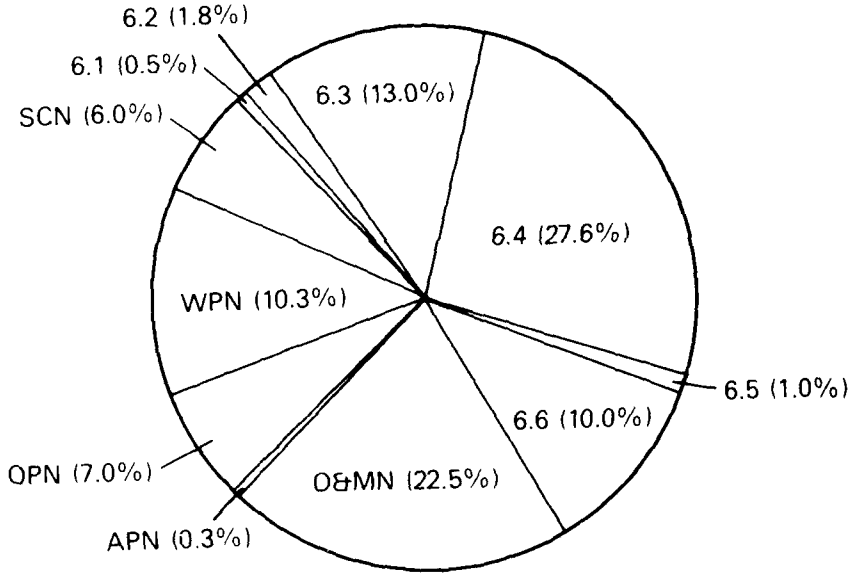

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WPN	Weapons Procurement, Navy
SCN	Shipbuilding and Conversion, Navy

30 September 1987

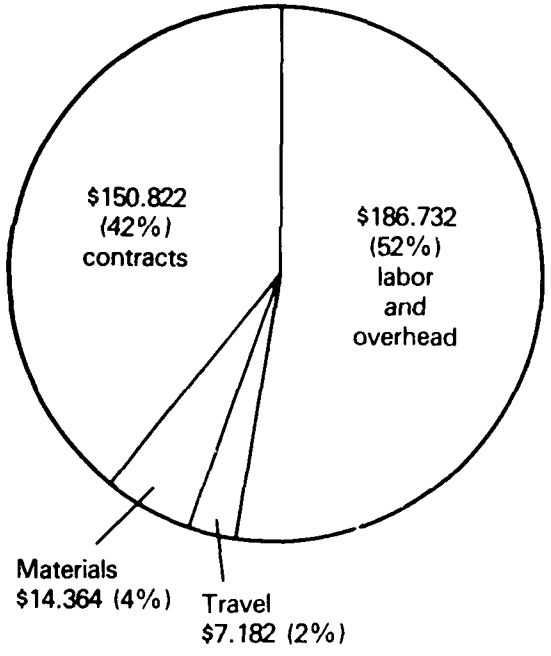
FUNDS BY CATEGORY AND TYPE (in $M)

CATEGORY	FY 1987	FY 1988
RDT&E (Category)		
6.1 Research and Development	1.055	1.281
6.2 Exploratory Development	3.991	4.609
6.3 Advanced Development	29.372	33.291
6.4 Engineering Development	62.370	70.680
6.5 Management and Support	2.239	2.560
6.6 Operational Systems Development	22.481	25.608
Total RDT&E	121.508	138.029
O&MN	50.817	57.619
OPN	15.881	17.926
SCN	13.579	15.365
WPN	23.285	26.376
APN	0.713	0.768
Other DoD	114.607	72.436
All Other	18.746	24.439
Total	359.136	352.962

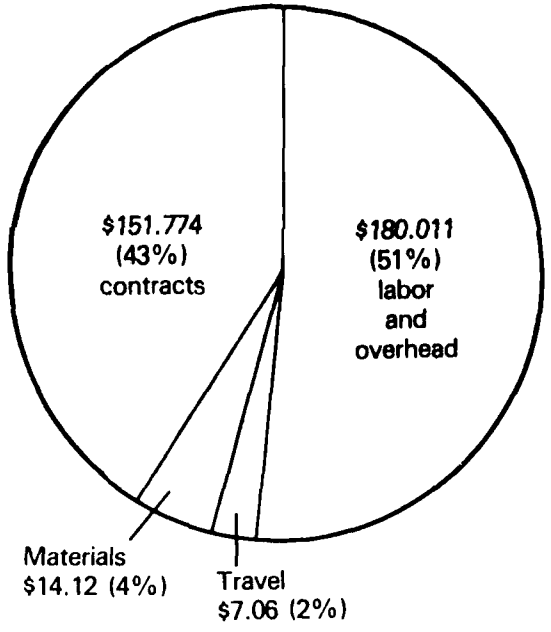
30 September 1987

DISTRIBUTION OF FUNDS
($M)

GFY 1987—actual $359.1



GFY 1988—estimated $352.9



NAVY MISSION AREAS

LEADERSHIP

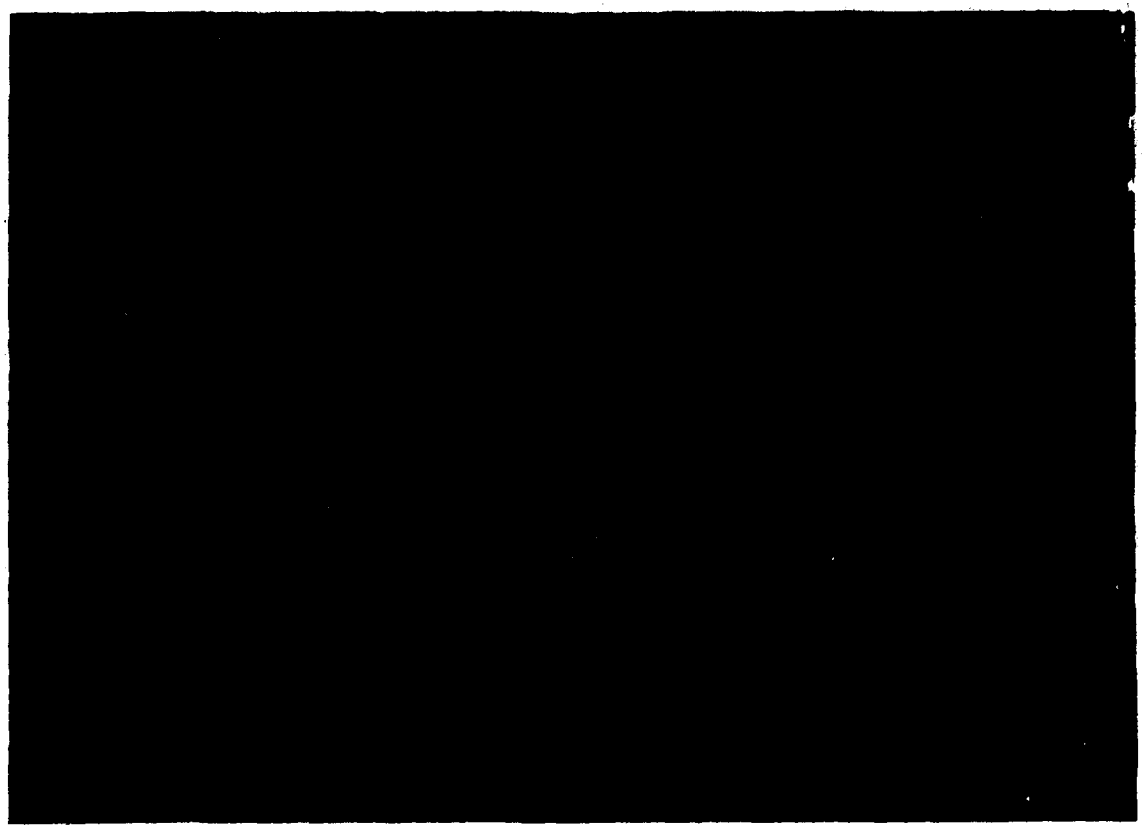
Ballistic missile systems test and evaluation
Fleet ballistic missile submarine security assessment

SUPPORT

Gun systems
Missiles
High power radiation devices
Launchers
Fire control
Electronic warfare systems
Vehicles
Acoustic reconnaissance and search
Special sensors
Ocean surveillance
Command and control
Communications
Navigation
Integrated combat systems
Environmental description and effects prediction
Space systems and technology

30 September 1987

AERIAL VIEW OF APL
HOWARD COUNTY, MARYLAND

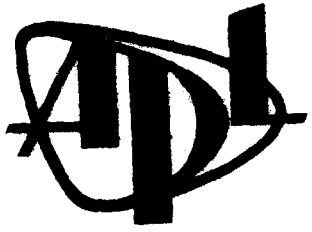


Approved: 1 January 1988

C. O. Bostrom

C. O. Bostrom, Director
The Johns Hopkins University
Applied Physics Laboratory

30 September 1987



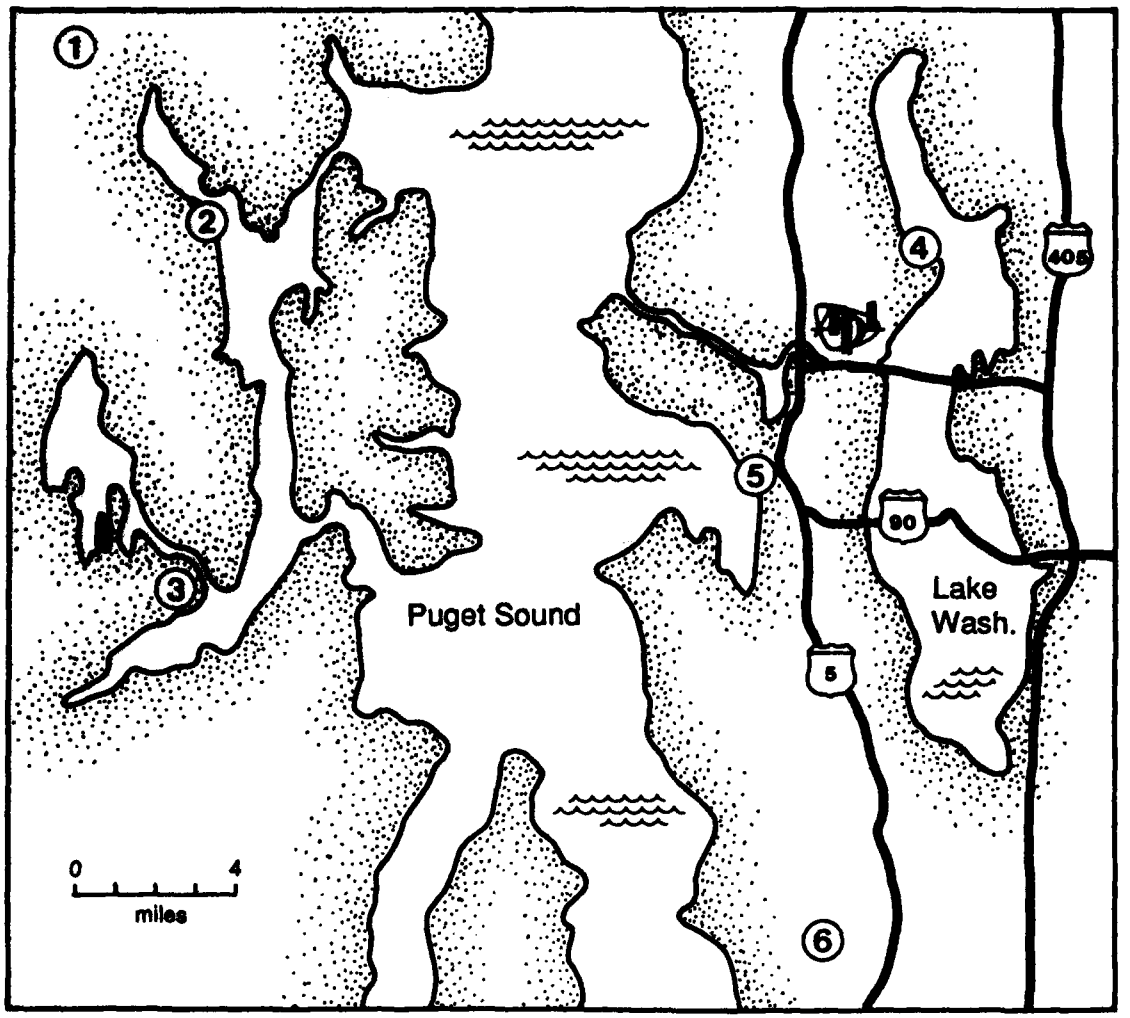
APPLIED PHYSICS LABORATORY
University of Washington

BRIEF

Seattle, Washington

30 September 1987

APL-UW



Seattle Area Locator Map

① Submarine Base, Bangor
② NUWES, Keyport
③ PSNS, Bremerton
④ Naval Station, Seattle
⑤ Downtown Seattle
⑥ Seattle-Tacoma Airport

APL Applied Physics Laboratory
University of Washington

30 September 1987

MISSION STATEMENT

Conduct a university-based program of fundamental research, technology advancement, and engineering support emphasizing naval applications of ocean science, ocean acoustics, and engineering.

INTRODUCTION

In the setting of a major research university, the Applied Physics Laboratory today is at the forefront of ocean research and technology. Founded by University of Washington physics professor Joe Henderson to aid the Navy during World War II, the Laboratory quickly established a reputation for innovation, a quality that remains a hallmark of APL programs. Now in its fifth decade, APL has greatly expanded the scope of its scientific and technological activities while continuing a commitment to Navy and national programs.

The Laboratory is a unit of the College of Ocean and Fishery Sciences at the University of Washington. Its staff members teach in several departments at the university, as well as supervise graduate student research at the Laboratory. Joint research projects with other units on campus tap expertise that complements Laboratory capabilities, and affiliate scientists from other institutions add to APL's reservoir of talent.

Laboratory scientists also serve on Navy committees and expert teams, providing valuable independent advice on critical research and development issues.

APL operates almost exclusively on sponsor funding. Primary sponsorship (88% of total funding) is from the Navy. NASA, NOAA, and NSF are also major sponsors of APL research.

As of 30 September 1987, the Laboratory employed 182 full time staff. Total funding obligated during FY87 was $18.3M.

University of Washington campus.

PROGRAM OVERVIEW

APL contributes to the nation's technology base through a program of basic research, applied research, and technology in the following areas.

OCEAN SCIENCE

APL conducts a program of theoretical and experimental research in the physics of ocean processes, particularly in the fields of small-scale mixing, internal waves, acoustic propagation in the complex ocean volume, and air-sea-ice interaction. Most of this fundamental research is performed in the traditional university manner by individual principal investigators and their associates. Principal investigators are responsible for obtaining funding and for managing their projects. The training of graduate students is an integral part of the ocean science program at the Laboratory.

OCEAN ACOUSTICS

APL has a long-standing interest in understanding the ocean environment in which acoustic systems operate, in particular advanced weapon systems that must exploit environmental acoustic conditions to optimize performance. This interest has led to our current work in high-frequency environmental acoustics and simulation. Laboratory programs develop acoustic measurement systems, conduct field experiments, formulate acoustic models, and develop ocean acoustic simulations to help design and evaluate weapon systems and system concepts.

OCEAN TECHNOLOGY

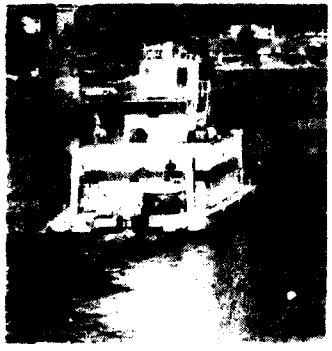
APL-UW's program of applied ocean technology evolved from the Laboratory's response to the Navy's need for reliable antisubmarine warfare technology. Our work in this field includes such specialized areas as advanced signal processing, electroacoustic transducers, artificial target systems, computer modeling, underwater range technology and implementation, marine corrosion, and underwater vehicle design, fabrication, and testing. New applications of these technologies are being investigated and implemented continuously, especially in areas of oceanographic research.

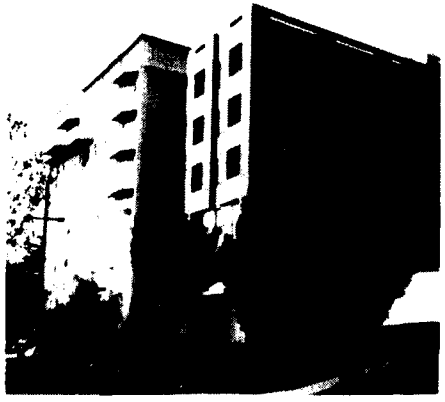
FACILITIES

The Applied Physics Laboratory occupies Henderson Hall on the west campus of the University of Washington in Seattle. Named after UW physics professor Joseph E. Henderson, founding director and widely respected advisor to the Navy, the APL building houses offices, laboratories, and shops. A new building wing was completed in 1987, bringing to 71,000 square feet the space available to the Laboratory. Additional space for storage and staging is nearby.

Buildings

RDT&E	67,572 square feet
Administration	3,428 square feet
Storage and staging	34,000 square feet





MARINE FACILITIES

The Laboratory maintains a small fleet of specially equipped boats to support its marine-related research and development projects.

Acoustic Research Vessel: This vessel is a 70' self-propelled twin pontoon "barge" that is utilized for general research activities and for acoustic transducer testing and calibration. Tests can be conducted pierside, in Lake Washington, or in the deeper water of Puget Sound. The vessel offers spacious interior laboratory work space that is fully equipped with modern test instrumentation and gear, including a vertical ram-type unit for lowering transducers into the water through the vessel's deck well. An overhead traveling crane can move equipment from within the laboratory to a position over the bow. Other features include a bow thruster to help steady the boat during maneuvers, anchor winches for three-point mooring in deep water, exterior mercury vapor lights for work at night, a 60-kW generator, radar, a fathometer, and VHF, citizens' band, and military frequency radios. The barge also has a galley, head, and sleeping quarters. A 17' motor launch is carried on field trips.

Utility Boat: Our 50' utility boat is fully equipped to serve a wide variety of marine research needs. There are fore and aft wells in the hull for placing transducers in the water; an overhead monorail system at the stern can be utilized for lowering and raising equipment from the water; forward space provides housing for a portable computer and a scientific work area; and the boat can carry a 17' motor launch if required. Electronic gear includes radar, two fathometers, a PA system, and VHF, citizens' band, and military frequency radios. The boat carries a 15-kW generator to run hoists, winches, scientific instruments, and utilities in the galley. Other features are bunks for six, a head, flying bridge controls, hydraulic steering, and mercury vapor flood lights.

Pier: The boats are moored at a steel pontoon pier located on Lake Union near the main Laboratory building. The pier also has a landing for sea planes. Power outlets are provided for equipment and utilities aboard the boats.

SHOPS

The Applied Physics Laboratory boasts of perhaps the most capable shops and manufacturing facilities in any college at the University of Washington. Highly skilled instrument makers, machinists, and electronic technicians are available to assist with engineering problems and design. Capabilities include tool design, precision machining, heat treating, welding and fabrication, sheet metal work, engraving, carpentry and engine repair. Also available are complete electronic design services (including CAD facilities), fabrication, and testing of electronic circuits.

ACOUSTIC CALIBRATION

Since 1950 the Laboratory has maintained facilities for the development and evaluation of hydroacoustic transducer systems. These facilities provide support primarily to the many Laboratory projects that utilize hydroacoustic transmission, but also to the Navy directly and to elements of the University of Washington such as the Medical School and the College of Ocean and Fishery Sciences.

The Laboratory's transducer group has essentially two interrelated capabilities. The first is in research and development. APL engineers design and assemble custom projectors and hydrophones for special purposes and provide, from specifications, single-element transducers or complex arrays. Our second capability is in the testing and calibration of acoustic transducers as well as complete electroacoustic systems such as torpedo homing systems and sonar projectors.

The Laboratory's calibration facilities can perform a variety of tests on transducer systems, including measurements of acoustic receiver sensitivities, transmitting source levels, transducer beam patterns, frequency responses, and impedances. The transmitting and receiving responses of units under test are compared with those of reference hydrophones and projectors that conform to national standards.

Transducer system evaluations are conducted either at the acoustic tank facility in the Laboratory or aboard the APL acoustic research barge.

COMPUTERS

Major computing facilities within the Laboratory consist of a Pyramid 98xe and two Digital Equipment VAX 750's. The Laboratory operates an artificial intelligence facility equipped with two Symbolics LISP machines. These machines support high-speed and high-resolution graphics in an integrated, object-oriented programming environment. APL research in artificial intelligence has concentrated on design of a computer system that provides an interactive and intelligent environment for time series analysis.

The Applied Physics Laboratory has recently acquired an image processing system to aid in automated extraction of data from repeated imagery. Consisting of an International Imaging System display and software, the system runs on a Masscomp 535 host computer.

TEST AND EVALUATION FACILITIES

APL-UW maintains an arctic field facility for the Navy Arctic Warfare Program. The arctic field facility includes the following general-use equipment (partial listing):

- Portable acoustic tracking range
- Thermal drills
- Communications equipment
- Weather observation equipment
- Logistics support equipment
- Diving equipment
- Messing and berthing facilities
- Satellite navigation equipment

In addition to the APL facilities, a wide range of University facilities is available, including the 206' oceanographic vessel R/V *Thomas G. Thompson.*

PROGRAMS

POLAR SCIENTIFIC RESEARCH

APL investigates the physical processes that control the nature and distribution of sea ice and currents in the polar oceans. Of particular interest is the relationship between sea ice and the global climate system. Satellite-tracked buoys, other specialized instrumentation, and satellite remote sensing techniques are employed to observe ice motion and to determine ice thickness distribution, age, and extent. APL also studies upper ocean dynamics in ice-covered waters to gain insight into energy exchange and thus the ice mass balance problem.

The goal of the Arctic Mixed Layer Dynamics program is to understand the dynamic and thermodynamic processes that cause changes in the velocity and density structure of the upper Arctic Ocean. Thus we study the heat and mass balance of the surface mixed layer, the upper ocean dynamics near the ice edge, and the dynamics of internal waves in the Arctic.

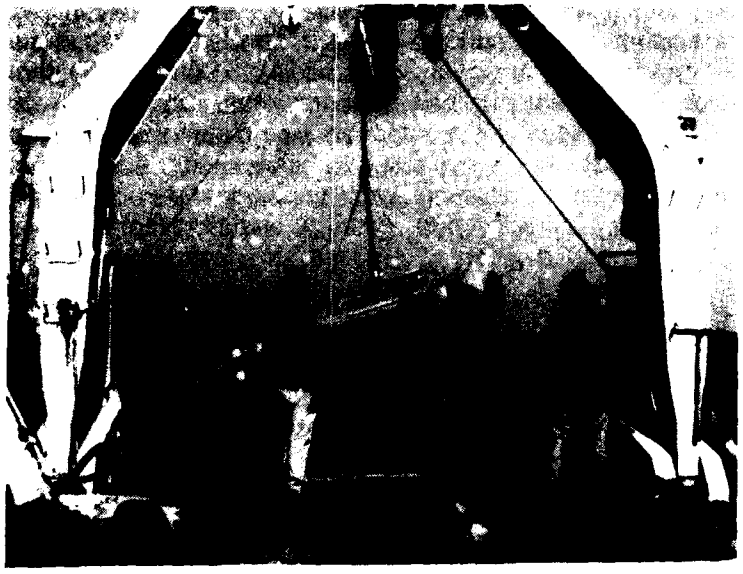
EXPERIMENTAL PHYSICAL OCEANOGRAPHY

Studies of the physics of energy transfer within the ocean are vital to our basic understanding of ocean currents, waves, turbulence, and sound propagation. Scientists at APL have pioneered a variety of special instruments and techniques that are leading to a new understanding of physical processes in the ocean.

The Laboratory's aim is to understand the dynamics of oceanic motions through measurement, data analysis, and simulation studies. Research concentrates on small and mesoscale processes in the upper ocean both in mid-latitudes and in the Arctic, particularly those processes associated with meteorological forcing, internal waves, and ocean mixing. Members of a major seagoing program, APL scientists participate in as many as six cruises a year.

ACOUSTIC SURVEY SYSTEMS

The Laboratory develops sophisticated in-field data acquisition and processing systems for acoustic survey. APL-designed state-of-the-art systems are currently being built to help NAVOCEANO modernize its methods of collecting environmental acoustic data that support the Navy's operating forces and acoustic system development. APL-UW efforts include the design and development of hardware and software as well as at-sea training in their use, as is being done for the Towed Automatic Reverberation Survey System (TARSUS). The Laboratory is also applying TARSUS software concepts to a family of NAVOCEANO signal-processing systems that will be used in the field for surveys and ashore for data assessment and database management.



HIGH-FREQUENCY ENVIRONMENTAL ACOUSTICS

Laboratory research and development programs investigate acoustic properties of the ocean and the physical processes that affect the performance of acoustic systems, with emphasis on high-frequency weapon sonar. Studies concentrate on ocean areas of particular interest to the Fleet, such as shallow water, the arctic ice-covered seas, underwater ranges where weapon and sensor tests are conducted, and other important operational areas around the world. Methods employed include theoretical analysis, field experiment programs, and computerized ocean acoustic simulations based on models generated by the theoretical and empirical work.

SPECIAL ACOUSTIC SYSTEMS

One of APL's longest running efforts has been the design and development of the AN/BQH-5(V)4 acoustic data logger, which conditions, monitors, annotates, and records data from several submarine sensors simultaneously and is suitable for a variety of measurement programs. The Laboratory maintains the software and designs modifications and refinements to the system as needed.

The Laboratory also developed the technology for a multibeam acoustic lens. The lens system has been used in a variety of ways, including high resolution mapping of ocean noise, and is being adapted for other applications including target detection.

GUIDANCE AND CONTROL

APL-UW has been developing and evaluating vehicle guidance and control system concepts since the early 1950's, including technology assessment studies for the Advanced Lightweight Torpedo program. This work led to identifying the importance of the underwater acoustic environment to the design and performance of advanced sonars, and APL has developed powerful tools for further investigations. Among these tools are a set of environmental acoustic models that have become the standard for high-frequency torpedo applications; a unique, extensive database of echoes from submarines, ice keels, fish schools, and bottom features; a database on the Quinault shallow water test range; and various simulations that incorporate or access these elements.

ADVANCED DATA PROCESSING

APL research in artificial intelligence techniques and applications takes advantage of rapid advances in software engineering, expert system shells, and computer hardware. In the area of knowledge engineering, the Laboratory is developing a diagnostic, knowledge-based system for isolating malfunctioning components on circuit boards.

TRANSDUCERS

Work in this area addresses research applications for tracking, homing, wake studies, communication, and arctic environmental studies, as well as acoustic transduction needs of underwater range tracking systems, vehicles, and ships.

The Laboratory develops transduction systems and provides services to support acoustic measurement instrumentation, artificial acoustic targets, navigational aids, and vehicles to be tracked on three-dimensional ranges. APL has an experienced staff of transducer experts and maintains extensive fabrication and test facilities, including a mobile acoustic research and calibration barge and an acoustic test tank.

UNMANNED UNDERWATER VEHICLES

APL's underwater vehicle team is experienced in all phases of vehicle development from generating functional specifications and performing feasibility studies to designing and fabricating prototype vehicles and instruments. New vehicles and systems are tested using major Navy and university test facilities, as well as portable acoustic tracking ranges suitable for a variety of environments including the Arctic. The team also provides technical consultation, special testing, and performance modeling for target vehicle programs.

ASW TARGETS AND COUNTERMEASURES

The Laboratory has over 35 years of experience in the design and development of mobile and stationary "targets" that simulate various submarine characteristics to provide a real-world training environment for Fleet USW/ASW forces and for testing and evaluating new weapons and sensor systems. Our work ranges from requirement studies and feasibility analyses through design and development of hardware and software systems and the translation of these designs into prototypes and experimental models. An active contributor to the Target Technology Exploratory Development Program, APL researches concepts and develops technology to extend target related knowledge and methodologies to meet the emerging Fleet requirements.

EXPLODERS

APL involvement with torpedo exploders dates back to 1943, when problems with the electromagnetic exploders were playing havoc with torpedo reliability. Successful resolution of that problem led to subsequent involvement in the design or technical support of most U.S. Navy exploders.

APL has been involved with the Mk 20 exploder since its development in 1959-60. Currently, we provide technical support, consultation, performance and reliability monitoring, failure analysis, and special purpose design and studies as needed.

SUPPORT OF ARCTIC RESEARCH AND SYSTEM TESTING

The ability to field complex scientific experiments successfully is a major strength of the Laboratory. Nowhere is this quality more important than in the hostile and unforgiving environment of the Arctic. Through research experience in the northern ice zones that extends back to 1971, APL developed the technology that makes large arctic expeditions possible. One of these technology contributions is the portable acoustic tracking range. This system is indispensable for testing underwater system from ice floes. APL has also developed several high-speed thermal drills for boring holes in the ice to recover research equipment or underwater vehicles.

As the main provider of field support for arctic research sponsored by the Office of Naval Research, APL works with scientists from Navy laboratories and academic institutions in numerous camps in the central Arctic, the Greenland Sea, the Beaufort Sea, and the Bering Sea. We also support large ice camps from which the Navy conducts Fleet system tests and related research.

UNDERWATER RANGES

APL originated the three-dimensional acoustic range concept and built the Navy's first permanent range in Dabob Bay, Washington, to monitor torpedo performance and to proof torpedoes for the Fleet. The Laboratory continues to develop and use tracking ranges, in particular portable ranges for special applications.

APL has developed a portable, long baseline system for deep-ocean tracking and data telemetry. This system provides highly accurate tracking of a surface ship and a submerged platform with respect to a fixed coordinate reference, and an acoustic data link capable of sending information over a 10-km slant range.

The Laboratory also supports various permanent ranges with new instrumentation (e.g., pingers for ships or towed arrays), hardware and software upgrades, and range tracking and acoustic reference arrays. These ranges include those that measure ship-radiated noise (Carr Inlet and Behm Canal) and those that test the precision, alignment, and calibration of ASW ship sensors (San Clemente Island and U.S. and NATO FORACS ranges).

APL also characterizes acoustic and environmental conditions at Navy underwater ranges. The Laboratory is currently gathering ambient noise data at a proposed acoustic range site in Behm Canal near Ketchikan, Alaska. The data will be used in developing a model to predict ambient noise based on local weather. An acoustic tracking and data link system optimized for the local environment will also result.

ASW SENSOR PERFORMANCE ASSESSMENT

The Laboratory initiated many ship sensor test concepts and techniques, including the Fleet Operational Readiness Accuracy Check Sites (FORACS) and the Weapon System Accuracy Trials (WSAT), and conducted the first comprehensive sensor and weapon systems tests in Dabob Bay.

APL has conducted special test and evaluation programs on specific sensor equipment such as major sonar systems. These evaluations involve controlled tests, usually on several systems, designed to identify specific class problem areas and to diagnose their causes.

MARINE CORROSION

APL and the Navy are engaged in a continuing effort to improve the reliability of submarine sonar transducers. The Laboratory is a principal participant in the Sonar Transducer Reliability Improvement Program to investigate transducer failures and develop designs to increase transducer reliability. Engineers identify and explain failures, autopsy Fleet and new transducers to identify failure modes and recommend corrections, define acceptance and rejection criteria and tests for transducers, and determine aging rates. Areas of expertise include sealing, cables and cable jackets, housings, cathodic protection, surface preparation, paint, corrosion prevention by design, coatings, stray current corrosion damage, connector design, and adhesion science. Related activities include development and presentation of courses to train Navy personnel in such areas as sealing, corrosion, materials, design, cables, transducers, and failure analyses.

LOW-FREQUENCY ACOUSTICS

APL, jointly with several other institutions, uses low-frequency acoustic remote sensing to map the time-variable "weather" on a large (1000 km) scale. Called Ocean Acoustic Tomography, the technique produces fields of sound speed and ocean current that characterize the ocean structure within the sampled volume. Already successfully demonstrated using fixed sources and receivers, the technique will next be tested in the Greenland Sea using fixed sources and moving receivers.

In a related project, Laboratory scientists are also investigating matched-field processing of low-frequency acoustic data for long-baseline seismo-acoustic array configurations.

MAJOR ACCOMPLISHMENTS

GRADUATE EDUCATION

Education of quality scientific and technical personnel to perform applied research is an integral part of APL's mission. In 1987 the Laboratory achieved a long-range goal by attracting ten new graduate students, bringing the total to twenty, most of whom are Ph.D. candidates.

ACOUSTIC SURVEY SYSTEMS

In 1986, APL delivered the Towed Automatic Reverberation Survey System (TARSUS) to the Naval Oceanographic Office. The first of a series of automated systems for data acquisition, analysis, and report generation, TARSUS gathers volume reverberation and bottom backscatter data in support of the Mk 48 and Mk 50 torpedo programs. The system consists of a towed measurement system and hardware and software for data acquisition and processing. The system has been deployed nearly continuously since delivery, and has produced more validated data than previously existed from all other sources. TARSUS technology is currently being extended through development of a series of acoustic information processing systems for survey aircraft and research vessels.

CHIME TRANSDUCER DEVELOPMENT

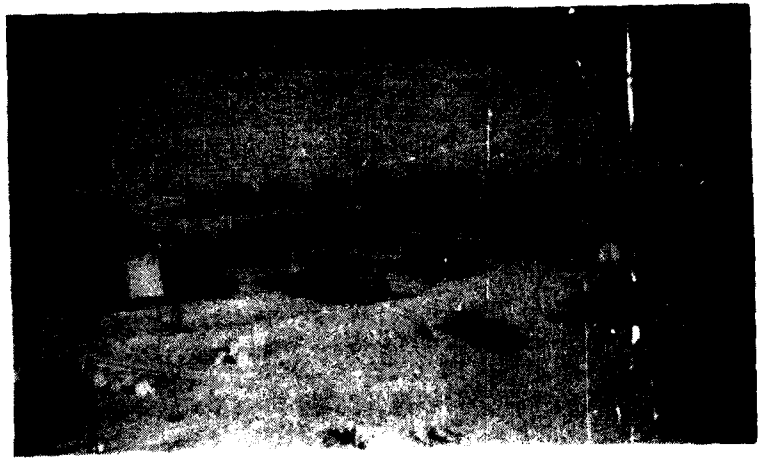
APL-UW has developed a unique transducer technology which holds considerable promise for achieving low-frequency transmission from a small package. Dubbed the "chime" transducer after its tubular shape and basis in mechanical resonance, the device features nearly constant beam patterns over varying frequencies and excellent efficiency over a bandwith of more than two octaves. The technology appears well suited for target and countermeasure applications. At the request of NAVSEA, the technology has been made available to several interested contractors. Work is continuing to explore the limits of the technology.

VORTICITY METER

During September 1987, an APL-developed vorticity meter was successfully tested aboard the research submarine USS *Dolphin*. This device directly measures the vorticity of sea water by using a seven-electrode sensor to measure the electric field induced by water motion. Although designed as a research tool to observe small-scale physical processes in the ocean, the vorticity meter may also find use in the study and characterization of wakes.

ARCTIC RESEARCH, TEST AND EVALUATION DURING ICEX 1-86 AND ICEX 1-87

Continuing a tradition of arctic acoustic research that dates back to 1971, APL was a major participant in ICEX 1-86 and



ICEX 1-87. Both exercises involved a wide range of work conducted by participants from Navy R&D Centers and Laboratories at field camps established on the pack ice by APL-UW. In addition to conducting research in acoustic scattering from the ice, APL supported virtually all other experiments through participation in planning, logistic support, technology development, operation of portable acoustic tracking ranges, and conduct of on-ice operations. Both exercises were unqualified successes, with ICEX 1-86 participants receiving commendations from the CNO.

AUTONOMOUS UNDERWATER VEHICLES

The Mk 38 mobile target, developed by APL as an expendable miniature target for training sonar operators, has been adapted as a vehicle for making oceanographic measurements. An active guidance and control capability has been added to the vehicle which permits on-deck survey track programming. Two versions of the vehicle are under development for under-ice applications. In the first, a bioacoustic assessment system has been installed to measure concentrations of krill (*Euphausa supurba*) under the antarctic ice pack. In the second, a conductivity-temperature measuring system will enable the vehicle to make horizontal profiles of those parameters across leads in the arctic ice pack, providing information on energy exchange in the Arctic Ocean.

ARCTIC MIXED LAYER DYNAMICS

Data from the Arctic Internal Wave Experiment (AIWEX) and the Marginal Ice Zone Experiment (MIZEX) nave been analyzed and give us an insight into the physics of energy exchange under the arctic ice pack. Internal wave energy was found to be one or two orders of magnitude less in the Arctic than in the open ocean, and may be related to ice motion. The marginal ice zone was found to have unique characteristics that could influence acoustic conditions. For example, horizontal variability and advection usually overshadow mixed-layer modification by turbulence, and internal wave generation can be a dominant cause of ice/water drag. Additional studies are

planned to better understand these dynamic and thermodynamic processes which influence the velocity and density structure of the upper Arctic Ocean.

In 1986, three automated buoys were installed in remote areas of the Arctic as part of a long-term program to obtain hydrographic data for the Naval Oceanographic Office. Seven additional buoys, which are designed to report ocean temperature and salinity in the upper 300 meters via ARGOS satellite, will be deployed during 1988.

A digital image processing laboratory has been established and is being used to develop methods of tracking ice motion using data obtained from synthetic aperture radar.

INTERACTIVE TIME SERIES ANALYSIS

A software system called TSA (for Time Series Analysis) has been developed and is being tested at several sites, including Navy R&D Centers. This effort is intended to explore how best to use the capabilities of modern high-speed personal graphics work stations for research in new statistical methodologies and for interactive data analysis. Features that take advantage of modern work stations are use of object-oriented programming language, use of a graphical control language, and use of graphical programming to facilitate algorithm incorporation. This software is currently implemented on a Symbolics LISP machine, but work is under way to port it to a Macintosh II, thereby making this capability available to a much wider user base.

MODULAR ADVANCED DIGITAL DATA SYSTEM

Originally developed as a solid state replacement for the digital magnetic tape recording system installed in the Mk 46 torpedo exercise head, the Modular Advanced Digital Data System (MADDS) architecture allows the recorder to be easily adapted to a variety of applications. Based on battery-backed, 4-megabyte modules, the system can be configured in as large a package as required (a 16-megabyte system is about the size of a shoebox). Sampling rates over 20,000 Hz are possible, and the system is easily interfaced with a PC for high speed data retrieval and analysis. The system meets all anticipated mine and torpedo program needs.

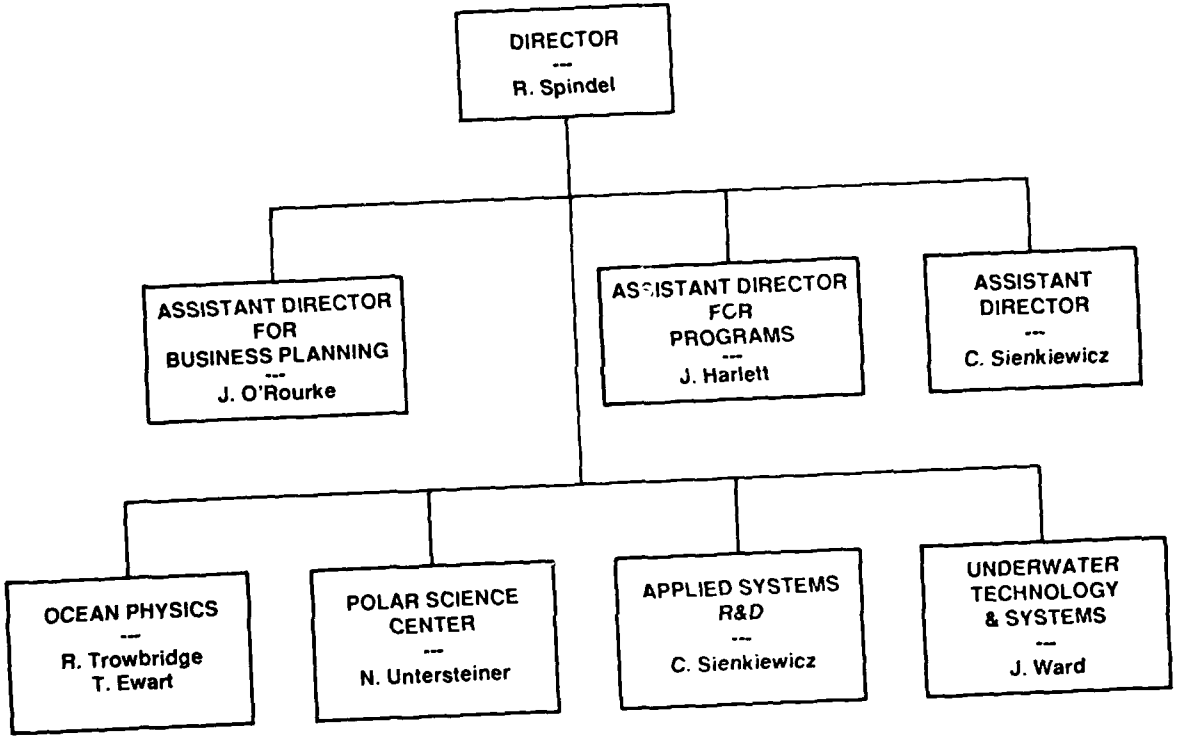
ACOUSTIC SCATTERING

Studies of bottom and surface acoustic scattering at frequencies from 10 to 500 kHz provide a basis for development of acoustic models for torpedo guidance and control and for mine warfare. These models serve as the Navy standard for weapon designers. Work to characterize bottom backscatter conditions at the Quinault torpedo test range has been completed. Data from this and ten other sites have been used to evaluate the APL-UW backscatter model, which proved to be an accurate representation of actual conditions.

A field experiment off Whidby Island to determine the effect of near-surface bubbles on surface backscatter, forward loss, and ambient noise was conducted in early 1987. Preliminary results show that for wind speeds in excess of about 10 knots the surface forward loss can exceed 10 dB.

APL-UW

Applied Physics Laboratory
University of Washington



30 September 1987

PERSONNEL DATA

Total On Board	FTP	TPTI
221	182	39

Breakdown of FTP:

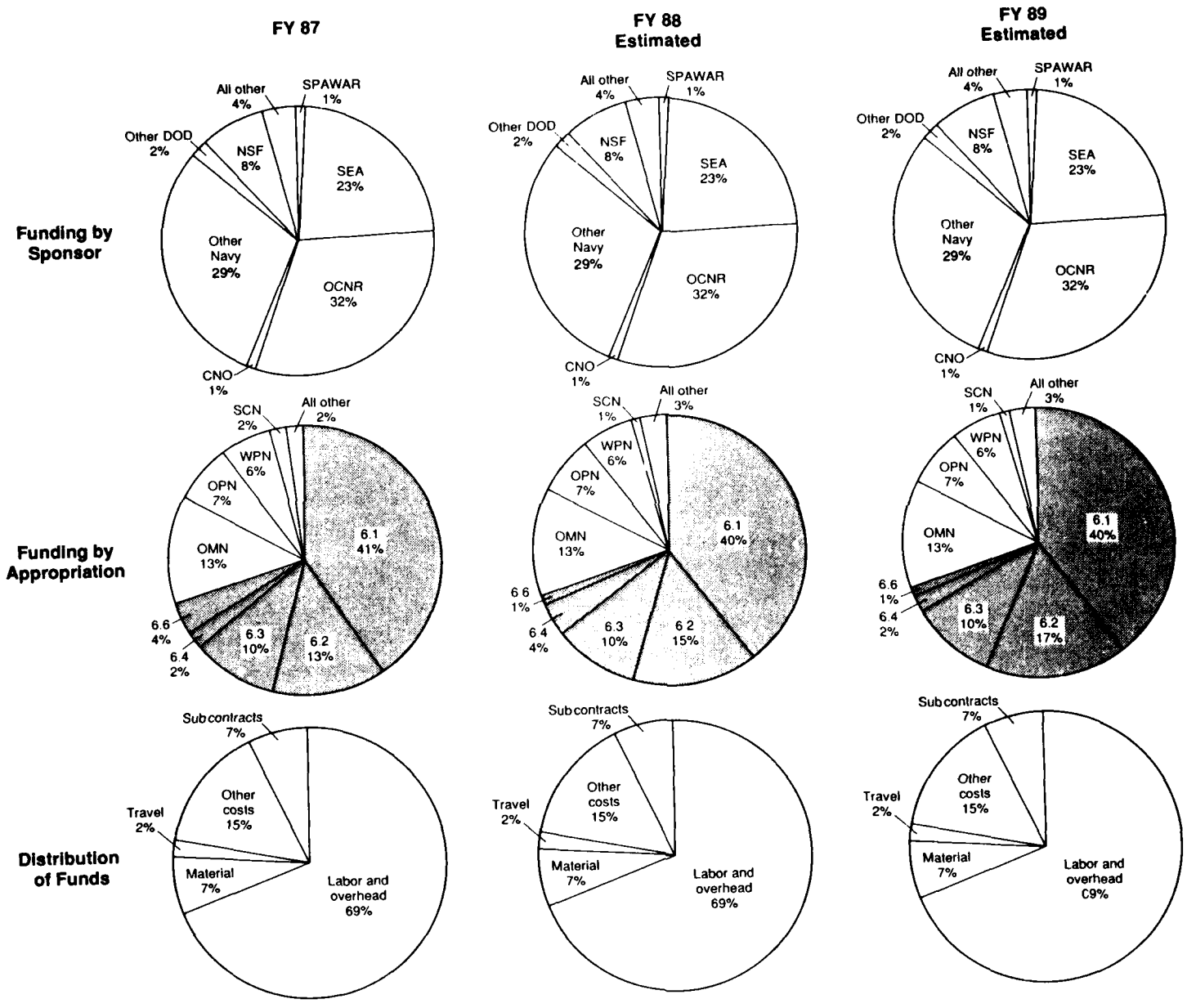
Scientists and Engineers	120
Administrative	37
Technicians	25

APL-UW FUNDING BY CATEGORY

CATEGORIES & TYPES	FY87 ACTUAL		FY88 ESTIMATED		FY89 ESTIMATED	
	$K	% Total	$K	% Total	$K	% Total
RDT&E						
6.1	7,462	41	7,700	40	8,100	40
6.2	2,349	13	2,900	15	3,400	17
6.3	1,741	10	1,900	10	2,000	10
6.4	393	2	700	4	400	2
6.5	28	--	--	--	--	--
6.6	743	4	200	1	200	1
TOTAL RDT&E	12,716	70	13,400	70	14,100	70
OTHER						
O&M,N	2,324	13	2,500	13	2,600	13
OPN	1,293	7	1,200	7	1,400	7
WPN	1,114	6	1,100	6	1,200	6
SCN	489	2	400	1	200	1
ALL OTHER	354	2	600	3	700	3
TOTALS	$18,290K	100%	$19,200K	100%	$20.200K	100%

APL-UW

APL-UW Funding Summary



30 September 1987

PENNSTATE

ARL

APPLIED RESEARCH LABORATORY

BRIEF

30 September 1987

PENNSTATE

ARL

MISSION STATEMENT

Within the provisions of the land grant charter of The Pennsylvania State University and within the Navy/University agreements to establish the Laboratory in 1945, ARL Penn State operates under the following broad three-part traditional mission.

— To conduct basic and applied research, exploratory and advanced development, and test and evaluation in support of the Navy's undersea technology base and related mission areas.

— To contribute to the educational objectives, research goals, and scholarly reputation of The Pennsylvania State University.

— To assist in the transfer of advanced technology and training to the governmental and industrial sectors for improved productivity and economic growth.

In the Navy's current perspective, the mission of the Applied Research Laboratory is threefold.

— To serve as the lead laboratory for research in the guidance and control of undersea weapons.

— To provide corporate memory and technical expertise in the area of advanced closed-cycle thermal propulsion systems for undersea weapons.

— To provide expertise in the areas of propulsor technology, hydrodynamics, and hydroacoustics for undersea vehicles and weapons.

INTRODUCTION

The Applied Research Laboratory (ARL) of Penn State is a Navy-oriented research facility established in 1945 to advance the Navy's technology base through research and development. ARL is the largest of the interdisciplinary centers on the Penn State Campus. The environment at ARL encourages collaborative research to utilize the multidisciplinary resources of a major university. ARL brings to this collaboration advanced research capabilities and real-world research problems.

In pursuit of its mission, ARL has developed the scientific expertise and technical capability to translate basic knowledge and ideas into applications by in-water field experimentation and feasibility demonstrations. Because of its sustained technical contributions over the past 43 years, its special facilities, and its accumulated experience and collective knowledge, ARL is recognized as the corporate memory and center of expertise in acoustically guided torpedoes and related technologies.

Although ARL concentrates its application interests in undersea technology, its depth of involvement has required the development of a broad base of technical expertise in the areas of underwater acoustics, noise and vibration control, hydrodynamics and hydroacoustics, propulsors, guidance and control, signal processing, thermal power plants, engineering materials, systems analysis, systems engineering, modeling and simulation, robotics and manufacturing science. This expertise is dependent on interdisciplinary knowledge drawn from most of the basic science and engineering fields.

Research on all torpedo subsystems, except the warhead, has been the major thrust of ARL since its inception. Involvement with undersea weapons spans the spectrum from the World War II MK-24 mine (FIDO) to concepts well beyond the current MK-48 ADCAP and MK-50 ALWT. Laboratory commitments to these programs include basic research, in-water tests of prototype hardware, and transition of major subsystems and concepts.

The hydrodynamic expertise and unique research facilities of ARL continue to support torpedo, submarine, and surface ship programs. Services to the Navy include torpedo project office support, management of the Advanced Undersea Weapons Guidance and Control Block Program for the Naval Sea Systems Command, Navy Science Assistance Program, and representation on Navy-sponsored study groups and committees.

ARL has a very successful record of anticipating future Navy needs, focusing research efforts to meet these needs, and expediting transition of research results to development programs. In addition, as a university laboratory, ARL is continually involved in educational activities through the teaching efforts of its staff who sponsor and supervise both graduate and undergraduate thesis research.

PENNSTATE

ARL

The ARL directorate consists of three positions: the Director, the Associate Director for Technology, and the Associate Director for Research. The Director is the chief administrator of the Laboratory, and is responsible to the Vice President for Research and Dean of the Graduate School at Penn State.

The Associate Director for Technology is the principal advisor to the Director on all development programs, and is responsible for interdepartmental coordination, budgets, and proposal preparation. Major programs involving more than one research department are managed by the Program Management Office under the direction of the Associate Director for Technology.

The Associate Director for Research is the primary liaison for research programs which are either basic or intercollege. The Associate Director also heads the business and support services including: business, personnel, security, computers, library, editorial, shops, and operation of the physical plant.

ARL is organized into six components along engineering disciplines and generic technology lines:

Guidance and Control Department Areas: Advanced Computational Architectures; G&C System Design Integration; Guidance Law Development; Signal/Image Processing; Numerical Modeling and Simulation; Pattern Recognition; Artificial Intelligence.

Power and Mechanical Systems Department Areas: Thermochemical Process Analysis; Thermodynamics and Heat Transfer; Numerical Modeling and Simulation; Power System Component Design and Testing; Propulsion Concept Development.

Fluid Dynamics and Turbomachinery Department Areas: Turbomachinery Design and Evaluation; Turbomachinery Noise Control; Boundary Layers and Drag Reduction; Cavitation; Computational Fluid Dynamics.

Systems Engineering and Acoustics Department Areas: Underwater Acoustics; Target Acoustic Signatures; Sonar Bottom Profiling; Acoustic Surveillance.

Engineering Materials Department Areas: Ceramics for Propulsion Systems; Ausforming; Metal Composites; Transducer and Electrical Ceramics.

Manufacturing Science Office Areas: Precision Inspection and Welding; Robotics; Arc Welding Technology; Vision and Sensors; Laser Materials Processing; Automation and Safety; CAD/CAM; Precision Engineering.

FACILITIES

The Applied Research Laboratory occupies the Applied Science Building and the Garfield Thomas Water Tunnel Building on the University Park Campus of Penn State. In addition, the Laboratory also maintains several remote test sites adjacent to the campus. Total acreage, building usage, and capital investment are as follows:

LAND:

Navy Owned	2 acres
University Leased	5 acres

BUILDINGS:

RDT&E	83,890 sq.ft.
Administrative	6,806 sq.ft.
Other	83,867 sq.ft.
Total	174,563 sq.ft.

ACQUISITIONS COSTS:

Real Property	(Classes I & II)	$ 7.4 million
Equipment	(Classes III & IV)	$12.3 million
	Total	$19.7 million

FLUID DYNAMIC RESEARCH FACILITIES

The fluid dynamic facilities operated by ARL constitute the largest and most complete university hydrodynamic experimental laboratory in the United States. These facilities are used for both basic and applied research supported by various academic departments, the Department of Defense, and private industry.

The initial operation of the 1.22-meter (48-inch) diameter Garfield Thomas Water Tunnel (GTWT) occurred in 1949. Since that time, smaller water tunnels and wind tunnels have been added. These include cavitation tunnels with 0.3-, 0.15- and 0.038-meter diameter test sections, a glycerine tunnel for studying boundary layer flow, a 1.22-meter wind tunnel, a subsonic cascade tunnel, and an axial flow fan air facility which can be operated with an anechoic chamber.

Data Acquisition and Reduction A considerable research effort is devoted to the development of advanced instrumentation and experimental techniques. Three-dimensional flow fields are measured using both laser velocimetry (LV) and pressure probes. The nonintrusive measurement of a velocity field with an LV is necessary for the study of the dynamics of swirling (vortex) flows, unsteady flows, and the boundary layers at a solid surface. During the past year, a three-component LV has become operational, which complements the simpler one- and two-dimensional units already in operation.

A parallel effort has developed a miniature (1.6-mm maximum diameter) 5-hole pressure probe which can record three-dimensional flow fields where an intrusive probe can be used. These probes obtain a simultaneous measurement of the three-dimensional time-mean velocity and pressure field. Both the procedures for calibrating and conducting measurements with these pressure probes and the techniques for their manufacture have been perfected. As a result, large numbers of these probes have been fabricated for the Navy labs and centers, NASA, and private industry.

Flow visualization is a major part of the study of fluid dynamics since it provides a description of the flow physics. The injection of

dye traces into a boundary layer permits the observation of the transition from a laminar to a turbulent flow. Smoke injection into a vortex in an air tunnel clearly displays the structure of the vortex when a portion of the flow is illuminated by a sheet of laser light or stroboscopic light.

While the original purpose of the GTWT was to provide a means of studying cavitation noise, it was not intended to be used for the study of noise in the absence of cavitation. However, advanced signal processing techniques do allow the study of relative noise characteristics. An array of hydrophones is installed at the end of the diffuser downstream of the test section and their output is transferred to a spectrum analyzer. To study the sources of unsteady forces on rotating devices and to identify means for their control, a 4-component sensor system was developed. Forces at frequencies as high as 1500 Hz are recorded.

Hardware Fabrication Precision model hardware is needed to study the surface effects of fluids. In addition to a standard machine shop, ARL operates both a 4-axis and a 5-axis computer/numerically controlled (CNC) milling machine to fabricate propulsor blades as part of a CAD/CAM system.

MECHANICAL, THERMAL, AND ACOUSTIC TEST FACILITIES

Pressure Test Facility Submersible structures and components are tested and evaluated at simulated depths in a pressure test facility. The facility includes three cylindrical fresh-water pressure vessels:

Pressure Vessel	A	B	C
Inside diameter (inches)	23	18.4	60
Inside length (feet)	5	14	13.75
Maximum pressure (psi)	3500	20000	16000

Engine-Noise Test Facility Propulsion and rotating machinery can be subjected to diverse tests under varied operating conditions, including underwater submergence and simulated back pressure in an engine noise test facility. The instrumentation produces data for detailed investigations of performance, noise, and vibration characteristics of an engine operating against a dynamometer load. Its specifications are:

- Pebble-bed air heater—can deliver air at preselected temperatures to 1740°F, preselected pressures to 1500 psi, and controlled and monitored flow rates to 5 lb./sec.
- Electric drive—solid-state-controlled ac/dc motor, variable speed 1 to 2250 rpm; 200 hp maximum.
- High-pressure air—two storage receivers of 85 cu. ft. capacity at 3000 psi; controlled flow rate to 14 lb./sec.
- Water brake—500 hp; 2000 to 5000 rpm.
- Dynamometers—600 hp; 2000 to 15000 rpm.
- Test pit—24 ft. × 8 ft. × 8 ft., open top; can be filled with water.
- Vibration isolation—three adjustable air-inflated mounts; capacity of 1500 lb. weight; 750 ft./lb. torque.
- Exhaust—back-pressure control valves for turbine engine exhausts up to 500 psi at 500°F.

Anechoic Tank The anechoic tank includes complete instrumentation for measuring and calibrating transducers and transducer arrays. Data measured include frequency-response

characteristics, directivity patterns, impedance and admittance over a frequency range of 1 kHz to 500 kHz. Pulse gating of the signals to sound projectors and from the receiving hydrophones permit measurement of directly transmitted sound levels before arrival of the first ambient reflection. Acoustic absorbing materials on the tank walls reduce the reverberation level to prevent interference with succeeding pulses. Its specifications are:

- Tank size — 26 ft. × 17.5 ft. × 18 ft.
- View ports — three 20-inch square windows suitably located for holography equipment
- Lighting — three portable 1200 watt underwater lights
- Tank opening — 26 ft. x 4 ft.
- Crane — 2-ton hoist and rail system

Dynamic Properties Test Facility The dynamic properties test facility was first developed to provide experimental confirmation of the predicted vibration response of damped mechanical systems and to measure the dynamic properties of elastomeric materials. Much of the apparatus in this laboratory has been specially designed and constructed at ARL, as there are no known commercially available counterparts; examples are: a simple mass-spring vibrator device, and fixtures for vibrating clamped circular plates, simply supported rectangular plates, and other configurations. The dynamic properties of elastomeric materials are determined by any of several existing testing arrangements. The laboratory also has general-purpose electronic equipment, test instruments, vibration transducers, and a unique two-stage 1800-pound seismic mass with a large Ling vibration generator. Experimental modal analysis capabilities have been added, and a file of more than 200 FORTRAN computer programs is available.

Tapered Acoustic Pulse Tubes The Laboratory has two water-filled pulse tubes for determining the acoustic properties of elastomeric layers and coating materials. The tubes are 17 and 29 feet long, respectively, and each is designed to operate over the frequency range of 1 to 100 kHz at pressures up to 1000 psi. The tubes have a unique tapered construction with measurements made on two-inch diameter disk-like samples that are either air or water-backed. This facility measures the echo reduction and acoustic decoupling characteristics of coatings, as well as the acoustic transparency properties of transducer window materials.

Power Plant Test Facility The remote test site for final preparation and testing of experimental power plant systems is located approximately four miles from the Laboratory. At this site, Stored Chemical Energy Propulsion System (SCEPS) boilers are loaded with lithium, starting charges are installed, and the end cover is welded in place. The building houses the power plant preparation area, an instrumentation room, a high-temperature and high-pressure steam supply. Sensors, data systems, and the required pumping systems are assembled and checked in this area. Boilers of any power level, from MK-50 to heavyweight torpedo size, are tested at this site. Special tests requiring the steam-supply system are also conducted. While the facility is used mostly for component or open-loop system testing, it also may be used for closed-loop testing, including dynamometer loading in all attitudes.

Test Vehicles ARL has developed a series of general test

vehicles (GTV) for concept evaluation and system-design support The GTV is powered by a modified MK-45 torpedo motor with a single-shaft output. The motor drives a pumpjet through a gear train designed by ARL. Unique motor mounts are part of the new installation. Silver-cell batteries provide energy for a six-minute run at 28 knots. A completely new microprocessor autopilot system employs rugged integrating-rate gyros on all three axes. This system affords sophisticated torpedo trajectory control, including closed-loop control by any homing system installed in the vehicle. The GTV is compatible with several nose sections and can accommodate experimental packages up to 50 inches long and weighing up to 500 pounds.

The present GTV configuration carries three magnetic tape recorders for data acquisition: a 14-channel analog recorder used for wide-band acoustic and vibration data; a 42-channel digital cassette recorder for vehicle status information; and a 9-track, IBM-compatible, digital recorder for sonar system data on a variable arrangement of wide-band and narrow-band channels. A Perkin-Elmer 8/16 computer is used for data reduction. Data from the cassette recorder are available to the field engineers within an hour after the vehicle returns to the shop. Data from the 9-track recorder are available in one to three hours, depending on the processing requirements.

COMPUTING FACILITIES

A VAX 8200 digital computer is available for general laboratory use. This machine is a 32-bit virtual memory super minicomputer with high-speed floating point hardware and 24 megabytes of main memory. Four high-speed disk drives with a total capacity of 1500 megabytes storage, three 6250/1600 bpi tape drives, two line printers (600 and 900 lpm) and 64 terminal lines are attached. Various graphic devices are available including a 5 ft. × 8 ft. flat-bed plotter and a Megatek 9200 graphics workstation.

Included in the available software is the DEC VAX/VMS operating system, a FORTRAN-77 compiler, a PASCAL compiler, an Ada compiler, the IMSL scientific subroutine package, the TEMPLATE graphics package, NASTRAN, ANSYS, a database management system, and a forms management system.

Two DEC VAX-11/780 digital computers are dedicated to data acquisition and reduction work for fluid dynamic and propulsor research. In addition, ARL has a secure computer facility using a DEC VAX-11/785 and a VAX 8200, an Ada software development facility with a Data General Eclipse MV/10000 computer, and VAX computers for CAD/CAM and IRIS, the Intelligent Robotic Inspection System.

Other Computer Assets The Laboratory has access to the University's computing facility (IBM 3081), as well as the Cray computing facility at Kirtland Air Force Base, New Mexico. The University is also a member of the Consortium for Scientific Computing (von Neumann Center at Princeton University).

GENERAL FACILITIES AND LOGISTIC SUPPORT OFFICES

ARL has complete in-house engineering and logistics support facilities including specialized shops, design/drafting facilities, a propeller-model-making facility (with 5- and 4-axis computer controlled milling machines), an Intelligent Robotic Inspection System (IRIS), and an electro-acoustic transducer fabrication room

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PROGRAM WORK

For over 40 years, ARL has sustained a successful record of technology transfer to Navy systems, predominately, but not exclusively, to autonomous undersea vehicles.

The major thrusts of ARL programs are in the areas of:

—Torpedo Guidance and Control
—Arctic Undersea Weapon Technology
—Concept Assessment for Weaponry
—Thermal Propulsion Technology
—Submarine and Surface Ship Technology
—Torpedo Quieting Technology
—Torpedo Defense Technology
—Manufacturing Science
—Undersea Technology Demonstration
—Fast/Deep Prototype Target
—Torpedo Propulsors
—Surface Ship Propulsors
—Torpedo MK-50
—Torpedo MK-48 (ADCAP)
—Remote Control of Mines (RECO)
—Production Acceptance Test and Evaluation of Torpedoes

Much of the program-related work and technical accomplishments, which are interdisciplinary in nature, are carried out in ARL's research departments. The departments are organized to support the following areas of expertise:

Guidance and Control:

Fundamental studies explore theoretical aspects of signal processing, information transfer between processing elements, and concepts in optimum control theory. The work in group theory is expected to lead to new digital implementation of basic signal processing algorithms and more efficient methods for computing transforms. The need for new distributed, massively parallel signal processing architectures based on VLSI and VHSIC chips has motivated the research in information transfer. Finally, advanced guidance and control systems for underwater vehicles require concepts from optimum systems theory. These include the application of artificial intelligence and pattern recognition technologies, and the understanding of computational complexity issues.

Closed-Cycle Thermal Power Plants:

Stored Chemical Energy Propulsion System (SCEPS) is a revolutionary propulsion technology. Current basic research studies in thermal power focus on characterizing and modeling the complex thermal-chemical reaction of the SCEPS-type systems. In these reactions, a gaseous oxidant is injected into a reactor of molten metal. The resulting reaction is highly energetic and creates a complex, multiphase flow field in the reactor.

Hydrodynamics and Hydroacoustics:

Hydrodynamic and hydroacoustic research at ARL is a full spectrum program extending from basic research to in-fleet applications. The primary research thrusts are concerned with the fol-

lowing: the hydrodynamic/hydroacoustic design and evaluation of propulsors and their manufacture, the characteristics of boundary layers and how they affect drag reduction and internal flows in turbomachines, computational methods for the prediction of hydrodynamic and hydroacoustic phenomena, and the development of improved experimental techniques.

Numerical Simulation and Modeling:

ARL's modeling efforts have been used in the following applications: to examine the acoustic properties of various ocean bottom types; to design specialized transducers to optimize directivity and sidelobe rejection; to predict the dynamical stability of various undersea vehicles; to evaluate candidate guidance and control systems for undersea vehicles; to investigate the false alarm problems associated with particular signal processors; to determine vehicle fuel requirements to meet specified mission criteria; to design propulsors to optimize performance; and to predict the acoustic reflectivity of objects given the structural design of those objects.

Engineering Materials Research:

Research and development in materials and materials processing address the undersea technology performance issues for propulsors, power transmission, thermal power, hulls and skins, and guidance and control. Material requirements are dictated by performance requirements which include: mechanical strength, stiffness, density, damping, cavitation resistance, thermal strength, conductivity and corrosion resistance.

Manufacturing Science:

The objective of the Manufacturing Science Program at ARL is to reduce the cost and improve the quality of ARL-developed systems and sub-systems, and then to transfer this technology to government contractors for implementation. The current thrusts of this program are dimensional inspection and laser materials processing.

MAJOR ACCOMPLISHMENTS

Guidance and Control

Recent progress includes the development of improved signal processing techniques for image recognition and classification, for noise rejection, and for increased control accuracy. In a self-noise test program using the GTV, data were recorded for each separate transducer element in an array using an on-board laser disk recorder. In addition, ARL participated in major Arctic programs in 1985, 1986, and 1987, obtaining acoustic data from both stationary and moving platforms.

Closed-Cycle Thermal Power Plants

SCEPS technology was incorporated into the Navy's MK-50 lightweight torpedo. Advanced SCEPS (ADSCEPS) technology was transitioned to in-water prototype demonstrations. The ADSCEPS power plant has achieved a significant increase in energy conversion efficiency, resulting primarily from improvement in the basic Rankine cycle of the working fluid. A new boiler-reactor and a microprocessor controller were developed for the greater power requirement of these advanced systems.

Hydrodynamics and Hydroacoustics

The transition of four propulsors has been completed and successfully demonstrated with trials at sea.

Another significant accomplishment has been the design and implementation of a high Reynolds number axial-flow pump test facility. With this facility, the hydrodynamic characteristics of boundary layers, cavitation, unsteady forces, and noise can be studied at blade chord Reynolds number of 3×10^7, higher than any other known laboratory experiment.

A three-component laser velocimeter (LV) has become operational which complements the existing two-component LVs. An optical holographic system is being used regularly to quantify the size and distribution of bubbles and nuclei affecting cavitation inception and noise.

Noise-related instrumentation has been advanced with the design and implementation of a 5-component probe system to sense unsteady propulsor generated forces. A computer-based interactive graphics data analysis (IGRAD) software package was developed to reduce and display large volumes of water tunnel data.

Numerical Simulation and Modeling

Simulations have been developed of undersea vehicle operation and their environment. These range from simple models of subsystems to models of major developmental systems. Artificial intelligence has been applied to the control of autonomous undersea vehicles, such as a prototype intelligent controller which uses object-oriented language.

Bayesian statistical techniques have been applied to the detection and classification of objects to permit the combination of expected knowledge with that gained during the mission.

Engineering Materials

Major materials science accomplishments during the past two

years include: producing damped materials by high-pressure casting of metal composites, establishing a damping and vibration measurement laboratory to characterize processed composites by conventional optical and innovative laser techniques, and establishing a facility for the thermomechanical processing of gears. Diagnostic techniques are under development which will quantify the effects of thermomechanical processing. Tape cast processing for the development of ceramic and metal composites for both thermostructural and drag reduced components have also been developed.

Manufacturing Science

The Intelligent Robotic Inspection System (IRIS) combines the application of laser and robot technology to produce a system capable of accurately measuring parts as large as 5 feet in diameter and 3 feet high to a precision of $\pm$.0005 inches.

A Laser Articulating Robotic System (LARS) manipulates a high-power (25-kw) laser beam over complex shapes with precision in a large working volume. One of LARS' unique capabilities will be to position the focused laser beam to a high degree of accuracy while welding as fast as 200 inches per minute.

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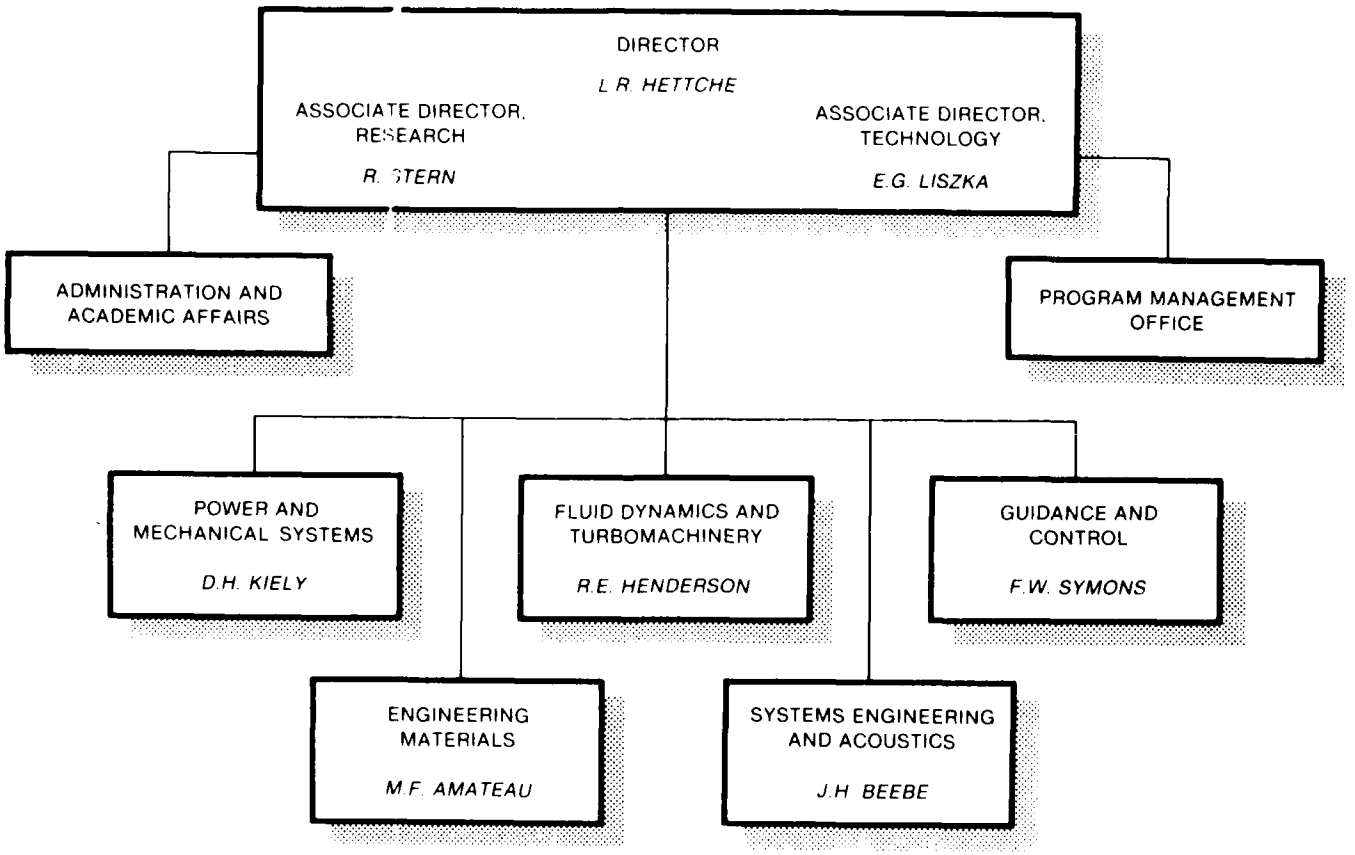
ORGANIZATION



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PERSONNEL

TOTAL ON BOARD	TOTAL MILITARY	TOTAL CIVILIAN	FTP	TPTI
536	0	536	354	182

BREAKDOWN OF PERSONNEL	TOTAL	FTP	TPTI
SCIENTISTS AND ENGINEERS	276	172	104
ADMINISTRATIVE	20	19	1
TECHNICIANS	120	64	56
OTHERS	120	99	21

BREAKDOWN OF FTP SCIENTISTS AND ENGINEERS BY DISCIPLINE	172
ACOUSTICS	10%
AEROSPACE ENGINEERING	11%
COMPUTER SCIENCE/MATHEMATICS/PHYSICS	17%
ELECTRICAL ENGINEERING	25%
MECHANICAL ENGINEERING	22%
OTHER ENGINEERING/SCIENCE	15%

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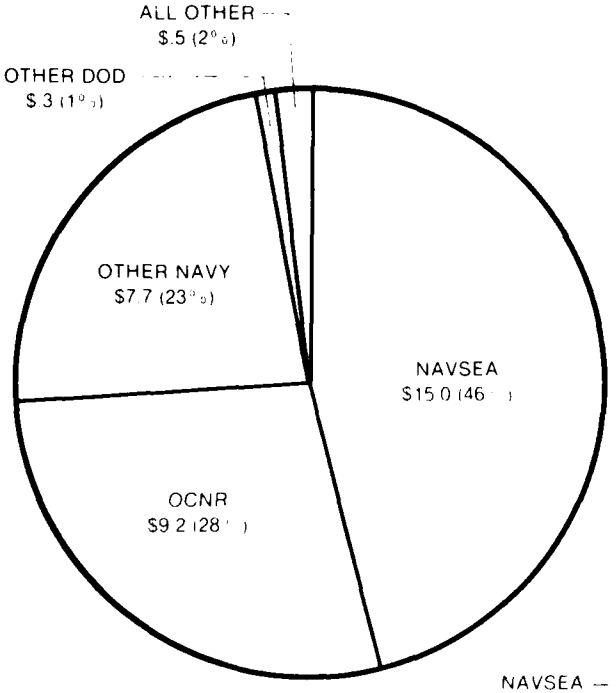
SOURCES OF FUNDS AND FUNDS BY TYPE

IN MILLIONS

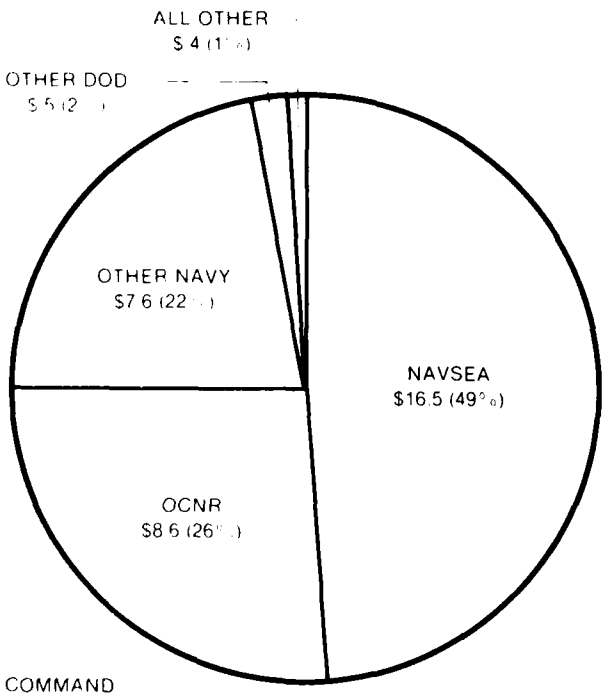
FY 1987

ACTUAL $32.7



FY 1988

EST $33.6



NAVSEA — NAVAL SEA SYSTEMS COMMAND
OCNR — OFFICE OF THE CHIEF OF NAVAL RESEARCH
DOD — DEPARTMENT OF DEFENSE

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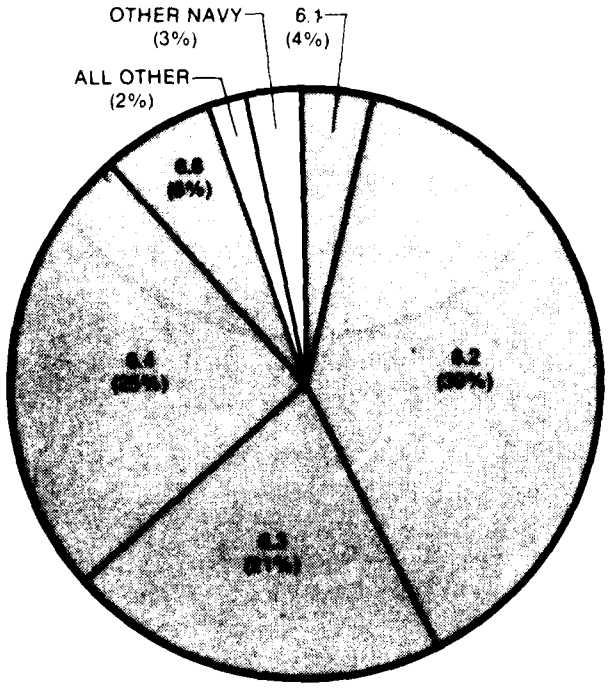
FUNDING BY APPROPRIATION

FY 1987



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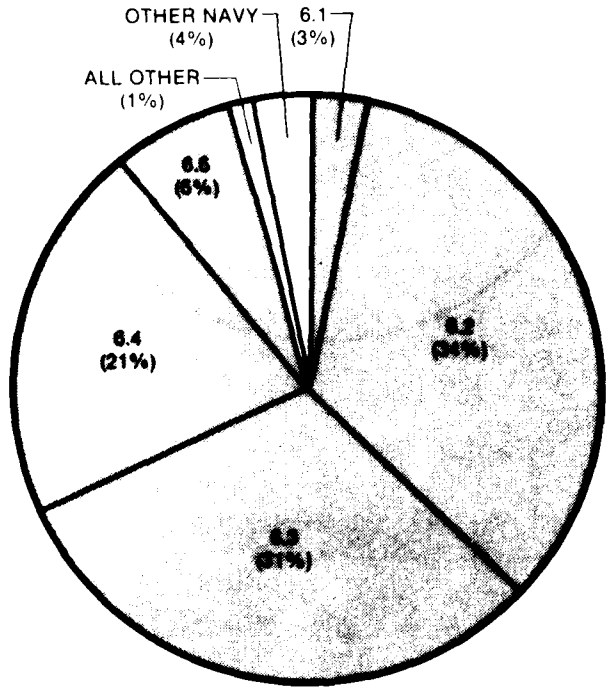

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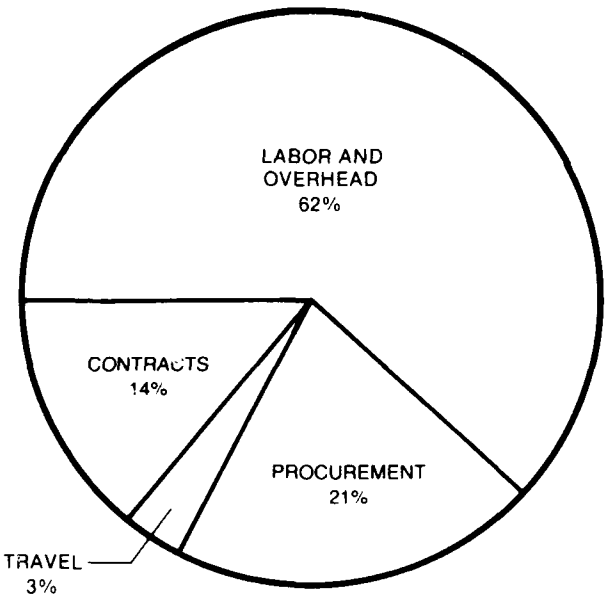
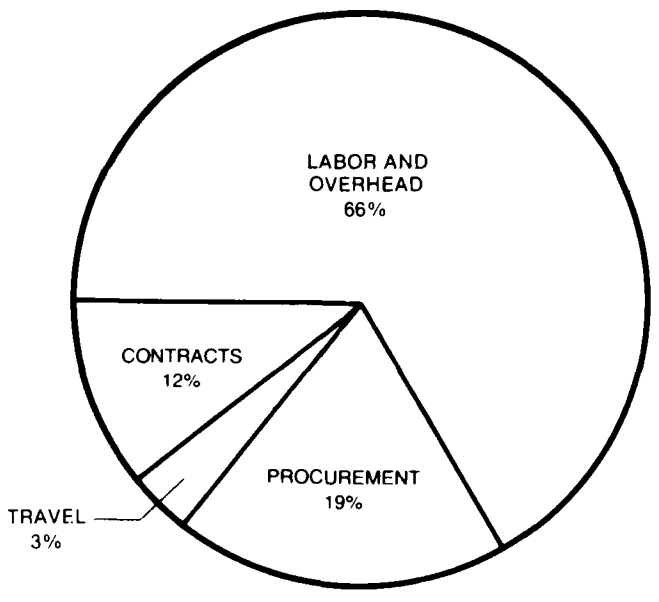
DISTRIBUTION OF FUNDS

FY 1987



FY 1988



30 September 1987

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LEADERSHIP ASSIGNMENTS

MISSION AREAS

- Undersea weapons guidance and control systems
- Advanced closed-cycle thermal propulsion systems for undersea weapons
- Propulsor technology and hydrodynamics for undersea vehicles and weapons

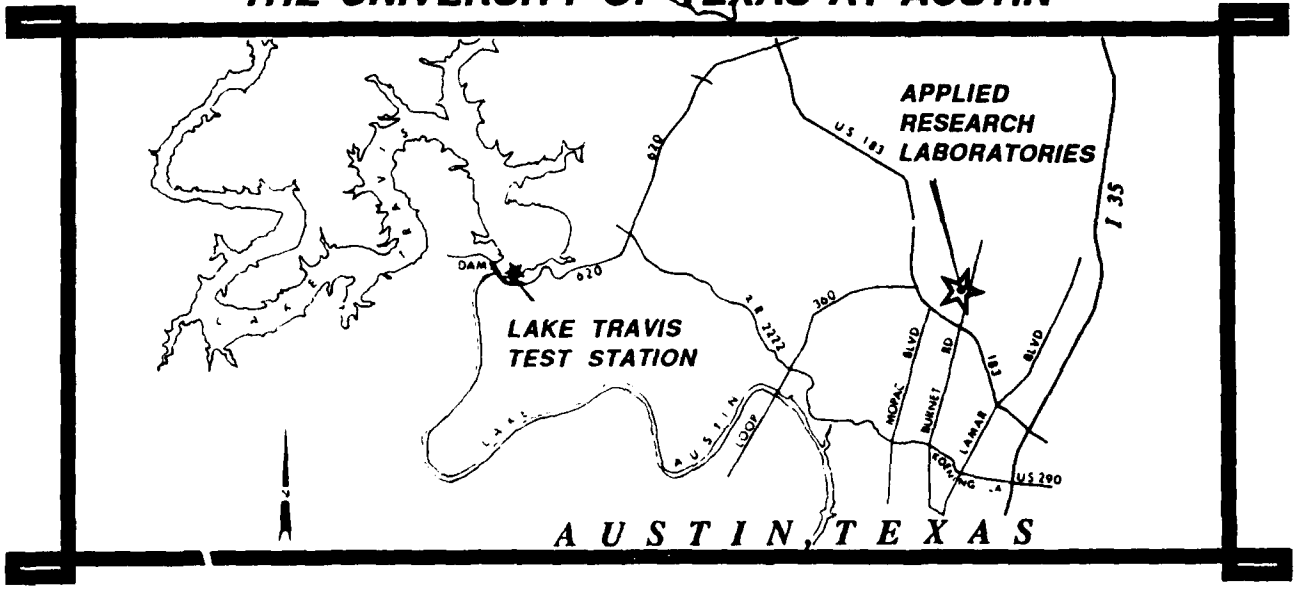
ROLES

- Primarily a technology base lab
- Lead laboratory for underwater weapons guidance and control
- Provides:
  - — Interface with university scientific resources
  - — Technical consultation and support to COMNAVSEASYSCOM and Navy R&D Centers in advanced and engineering development (6.3 and 6.4) and manufacturing technology
  - — Corporate memory and expertise for Stored Chemical Energy Propulsion Systems (SCEPS) technology
  - — Concepts and demonstrations
  - — Modeling and simulation

BRIEF

30 SEPTEMBER 1987

APPLIED RESEARCH LABORATORIES
THE UNIVERSITY OF TEXAS AT AUSTIN



30 SEPTEMBER 1987

MISSION STATEMENT

The mission of the Applied Research Laboratories:The University of Texas at Austin (ARL:UT) specifically includes (1) the conduct of basic and applied research, exploratory and advanced development, systems engineering/analysis, test, evaluation/assessment, and technical field support to provide effective solutions to DoD and Navy warfare problems in acoustics and electromagnetics for surface, subsurface and space environments; (2) the interpretation and transitioning of the results of basic research from academia to Navy Centers, Development Commands, Operational Forces, other government agencies, or industry; and (3) the continued contribution of fundamental scientific advancements in acoustics and electromagnetics.

30 SEPTEMBER 1987

INTRODUCTION

Applied Research Laboratories, The University of Texas at Austin (ARL:UT) is a mission oriented, problem solving activity which conducts programs of basic and applied research, development, engineering, testing, evaluation and assessment germane to the defense of the United States. ARL:UT evolved from two defense-oriented research laboratories established by The University during World War II. The Defense Research Laboratory (DRL), established in 1945 to conduct R&D on U.S. Navy surface-to-air guided missiles, had its charter expanded in 1949 to include underwater acoustics. The present-day ARL:UT evolved from the merger in 1964 of DRL and The University's Military Physics Research Laboratory. As an integral component of the research and related instructional programs of The University, ARL:UT performs those functions long established as appropriate for a university laboratory -- teaching, research, and public service. In keeping with the role of a non-profit university research unit, ARL:UT does not compete with industry.

Throughout ARL:UT's history, the bulk of its research program has been sponsored by DoD agencies, principally the U.S. Navy. In some basic technical areas of acoustics and electromagnetics, ARL:UT has a history of more than 30 years' involvement. Historically, ARL:UT has effectively addressed problems and demonstrated exceptional technical expertise in the following areas: high resolution/high frequency sonar; effects of the medium on acoustic and electromagnetic signal propagation (ocean, sediment, ice canopy, atmosphere, ionosphere, troposphere); low frequency, long range acoustic propagation; information and data management/collection; signal processing and displays; acoustic mine mechanisms; mine countermeasures; ASW active sonar; ASW passive sonar (mobile, fixed/distributed); measurement/analysis of properties of the target; nonlinear acoustics; transducer fabrication, array design/prototyping, and calibration; fire control; communications; torpedo countermeasures/counter-countermeasures; and navigation and precise location using existing satellite systems.

A staff of approximately 450, including more than 160 scientists and engineers and 20 faculty members, conducts an overall annual technical program on the order of $21-25M. The University's strong commitment to academic excellence works to ARL:UT's advantage in that outstanding faculty as well as top quality students are attracted to the University's science and engineering departments, ensuring high quality personnel in all scientific disciplines. ARL:UT maintains a number of highly specialized physical resources oriented toward addressing undersea warfare problems. These resources are described in the "Facilities" section of this brief.

Management goals include: maintain a creative work environment; maintain significant involvement in science and technology; maintain the breadth of expertise needed to couple scientific opportunities from academia to Navy warfare problems; maintain the technical resources and flexibility to provide quick response to unanticipated critical military problems; and minimize administrative commitments for scientists and engineers.

ARL:UT is located at The University of Texas' Balcones Research Center (BRC) in the Northwest part of Austin, Texas, approximately 8 miles from the main campus. The BRC research complex encompasses more than 400 acres, of which ARL:UT uses about 28 acres. The University also leases 24.9 acres from the Lower Colorado River Authority at Lake Travis, about 18 miles from BRC, on which is located ARL:UT's acoustic test facility, Lake Travis Test Station.

FACILITIES

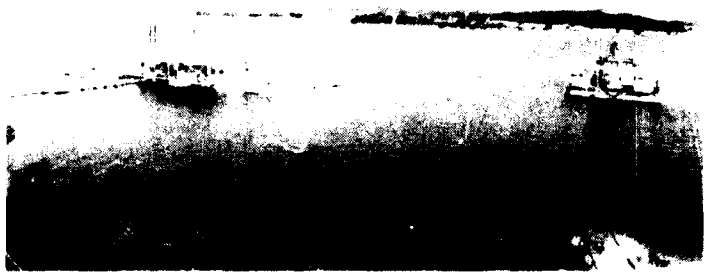
GENERAL

ARL:UT operates several specialized facilities which support a variety of Navy/DoD projects. Those capabilities that are especially conducive to solving undersea warfare-related problems include: acoustic testing and sonar calibration; pressure testing; transducer fabrication, calibration, testing and repair; printed circuit card construction, analog to digital data conversion, and extensive computing capability, including secure computing facilities for processing classified data. ARL:UT also has access to and uses a number of University of Texas facilities including the extensive technical libraries and the Cray XMP/24 supercomputer. Acreage, building usage and capital investment are as follows:

Land Owned/Leased	52.9 acres
Buildings	
RDT&E	87,118 sq ft
Administrative	9,499 sq ft
Other	17,218 sq ft
Acquisition Costs	
Real Property (Classes I & II)	$ 34,340
Equipment (Classes III,IV, V)	$7,073,699
University Buildings	$1,350,000
University Equipment	$5,765,106

LAKE TRAVIS TEST STATION

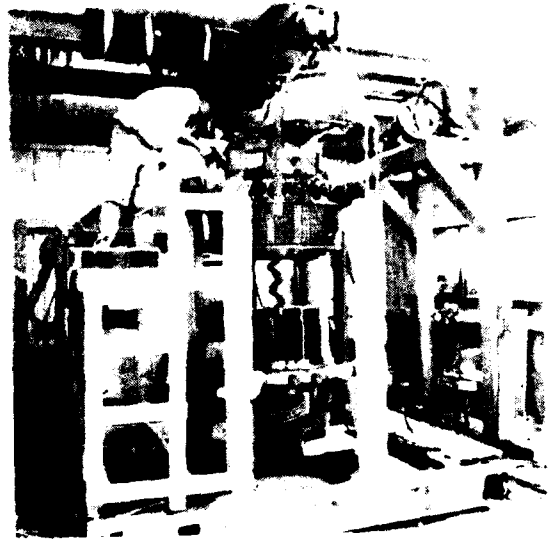
ARL:UT's Lake Travis Test Station (LTTS) consists of two barges with a total of 4949 sq ft of enclosed laboratory space fully equipped with updated test, calibration, and data recording instrumentation. Water depth directly beneath the barges is typically 70 ft. Barge motion is nominally less than ±2.0 during inclement weather and less than ±0.2° on calm days. Test frequency ranges are 100 Hz to 1.5 MHz. Transmit and receive pulse mode durations can be varied from 0.01 msec to 1.10 sec in steps of 0.01 msec with repetition rates between 0.1 Hz to 1.1 kHz.



LAKE TRAVIS TEST STATION

LTTS is equipped to handle transducers weighing up to 60,000 lbs. In addition to the calibration and test facilities, ARL:UT operates an AN/SQQ-14 testbed sonar and a computer controlled simulator for exercising torpedo homing heads at LTTS. An experienced dive team, principally scientists and engineers, is available for underwater hardware installation and servicing. Fully operable year round, LTTS has experienced heavy usage throughout its 30-year history.

FACILITIES (cont.)



AN/SQQ-32 SONAR BEING READIED FOR TECHNICAL TESTING AT LTTS

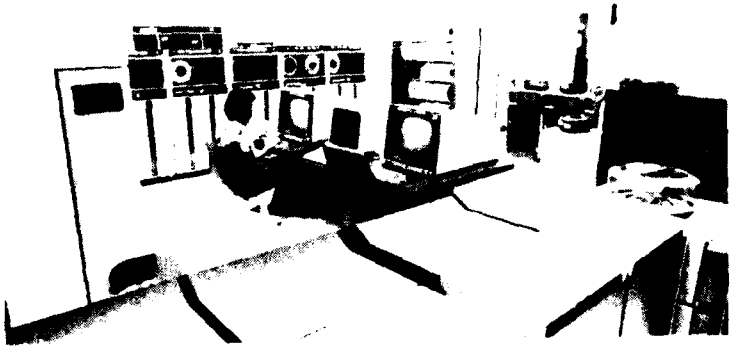
SONAR MODEL TANK ROOM

Two indoor, freshwater acoustic test tanks measuring 60 ft X 15 ft X 12 ft are used for transducer research and testing, reflection and scattering studies, and echo structure studies. Target and transducer test equipment having a load handling capability of up to 4000 lbs is operated in the model tank room. One of the tank bottoms is covered with a 3 ft deep layer of sand for studies of acoustic propagation in sediments and reflection from buried objects. Computer controlled instrumentation is used for positioning transducers and recording data. Effective test frequency range is 5 kHz to 2 MHz. The range of other test parameters is identical to that of the instrumentation at LTTS. Complementing the indoor acoustic test tanks are two cylindrical wooden tanks located just outside the main laboratory building and measuring 55 ft in diameter by 39 ft in depth and 20 ft in diameter by 8 ft in depth.

COMPUTATION CENTER

Five computer systems having highly specialized capabilities support research efforts - a CYBER 830, an Alliant FX/8, a Digital Equipment VAXstation II, a dual Hewlett-Packard 1000 system, and a CYBER 171 which will be retired in FY 88. Large scale timesharing and computational needs are met by the CYBER 830 and Alliant FX/8 systems. The Alliant FX/8 provides a vector and parallel architecture that can be used to achieve low end supercomputer performance. The VAXstation II provides high resolution (1024 X 860 pixels) color graphics and hardcopy that allow researchers to experiment with color presentation schemes to aid artifact identification in processed data. The Hewlett-Packard systems are interfaced to a Preston analog to digital (A/D) unit that provides 16 simultaneous sample and holds connected to a 300 kHz, 15-bit converter. A maximum digitizing throughput rate of 270 kHz has been attained with output to magnetic tape possible in either 1600 cpi or 6250 cpi format.

FACILITIES (cont.)



CYBER 830 COMPUTER FACILITY

TRANSDUCER FABRICATION

More than 20 years of experience in the art of transforming raw ceramic into an effective, seagoing acoustic projector or receiver reside in ARL:UT's transducer fabrication facility. This facility is equipped to cut, silver, and polarize raw ceramic material for fabrication of complete sonar transducer arrays. Transducers ranging from miniature probes to large ASW-sized arrays can be built. Personnel are skilled in using various plastic and rubber molding compounds in packaging the completed devices. Innovative transducer development is fully supported by this facility and the test and calibration facilities in the Sonar Model Tank Room and at LTTS.

MACHINE AND ELECTRONIC SHOPS

ARL:UT's well-equipped, precision machine shop is ideal for constructing the transducer housings, precision special purpose instrumentation, special jigs, and other one-of-a-kind equipments so essential to research and development efforts. A fully equipped electronics shop permits timely, on site fabrication of special purpose electrical circuits as well as instrumentation calibration and repair, hard and soft anodizing, silk screening, and on site printed circuit card fabrication starting from preliminary art work prepared by the research scientist or engineer. These facilities provide the ARL:UT researcher greater flexibility with respect to design changes in an exploratory or advanced development device.

PRESSURE TESTING

Four pressure vessels used for hydrostatic testing are maintained by ARL:UT. Pressure ratings for these vessels are 500, 750, 1000 and 5000 psi with volumes to 250 cu ft. A 30,000 lb hoist mounted on a monorail extends over the largest pressure vessels to raise and lower the devices to be tested.

PROGRAM WORK

There are currently more than 50 active research, development and engineering tasks at ARL:UT. This program of work supports five Naval Warfare areas (anti-ship warfare, anti-submarine warfare, mine warfare, ocean surveillance, special warfare), Defense Mapping Agency mapping, charting, and geodesy, Army operational testing, and Air Force and NASA Global Positioning Satellite (GPS) applications. The major areas of program work are noted below along with principal projects in each area.

HIGH RESOLUTION SONAR

- Design and development of modular architecture for high resolution sonar systems
- Design and development of the deep submergence obstacle avoidance sonar for USS DOLPHIN (AGSS 555)
- Design, development and implementation of the data collection system supporting the design of the AN/SQQ-32 advanced minehunting sonar
- Participation in the design and development of the AN/SQQ-32 advanced minehunting sonar
- Technology development of acoustic sensors for unmanned vehicles
- Development of the prototype underice navigation/obstacle avoidance sonar (EXUS)
- Participation in the development of the submarine mine avoidance sonars (AN/BSY-1 and AN/BQS( ))
- Development of a waterside security system using acoustic sensors
- Assessment of the acoustic effects of the environment on high resolution sonars
- Development of advanced signal processing technology to support automatic detection and classification of small targets

ASW PASSIVE SONAR

- Development of numerical acoustic models to support narrowband and broadband acoustic signal propagation studies
- Development and implementation of real-time acoustic performance prediction systems for Fleet applications
- Acoustic assessment of the IUSS system
- Design and development of prototype deep ocean directional acoustic sensors using pressure tolerant electronics
- Design of exercise, collection of data, processing and analysis of environmental acoustic data collected via shipboard and airborne platforms
- Design, development and evaluation of higher order spectral processing techniques for ASW application
- Development and application of "roll-on, roll-off", low cost high density recording systems for calibrated acoustic data collection via Fleet aircraft
- Studies of the effects of environmental limitations on passive sonar sensor design and performance

PROGRAM WORK (cont.)

- Participation in the CUARP program on detection of broadband acoustic signals

ASW ACTIVE SONAR

- Design and use of automated data collection system for measuring the target strength of submarines
- Development and testing of a computer assisted (automatic) classifier for surface ship sonars
- Development of signal processing algorithms for enhanced detection and classification in a multitarget environment
- Participation in the CUARP program on active sonar classification

TORPEDO COUNTERMEASURES

- Studies of sensor configurations for torpedo defense systems for surface ships
- Studies of algorithms for torpedo counter-counter-measures

ACOUSTIC MINE MECHANISMS

- Participation in development of the Advanced Sea Mine (ASM) as a member of the U.S. development team
- Determination of limitations placed on advanced acoustic mine mechanisms by the environment
- Development of a data collection system to support future mine mechanism design and development

INFORMATION AND DATA MANAGEMENT

- Participation in the University Research Initiative on parallel computing with faculty of the UT Computer Science Department
- Development of software engineering methodologies for large and small systems
- Investigation of the application of knowledge based methods for the information management for a system with many sensors
- Design and development of very high speed input/output engines for advanced computing devices

SATELLITE GEODESY

- Development of a portable Global Positioning Satellite (GPS) receiver for geodetic applications
- Development of GPS fixed site monitoring instrumentation for geodetic applications
- Modeling studies on ionospheric and tropospheric propagation of electromagnetic waves
- Integration of GPS precise positioning capabilities and methods for shallow water bathymetric surveys and land surveys for mapping and charting

MAJOR ACCOMPLISHMENTS

DEEP SUBMERGENCE SONAR

The deep submergence/obstacle avoidance sonar was installed aboard USS DOLPHIN in June 1987 after a two year development cycle. This unique high resolution sonar is state-of-the-art in modular, compact sonar design. The architecture sets up sonar building blocks, with generic hardware having distributed processing, allowing incremental addition of arrays of arbitrary geometry and alternate operating frequencies, and using common signal conditioning, inboard signal processing, and display equipment. The design permits application to a broad range of submersibles with minimal redesign. A significant advancement in information processing is manifested in a color refreshed display system. Initial sea trials on DOLPHIN have demonstrated excellent capability to detect, track, and navigate with respect to small objects on the sea surface, in the water column, and on the sea floor. The system is fully calibrated for absolute measurement of acoustic parameters of the medium. Digital recording of beamformed signals is also available. Experiments to demonstrate mine avoidance, advanced signal processing, object tracking, and navigation are planned.

SPARS

ARL:UT developed a minicomputer based acoustic performance prediction system for the Integrated Undersea Surveillance System (IUSS). SPARS is the primary vehicle for providing acoustic performance analysis capability to the Fleet. SPARS systems are used daily at COSP and COSL, where they provide an easily accessible way to evaluate the impact of the ocean environment on the performance of surveillance systems. The system provides an integrated, readily used ability to examine environmental databases and obtain model calculations and performance estimates. SPARS provides the flexibility to use measured quantities vice model calculations when measurements are available. SPARS products are used to assess/interpret data from surveillance systems as well as to plan system deployments.

IUSS ASSESSMENT STUDIES

ARL:UT has conducted assessment studies on future deployment planning and advanced sensor design for FDS and ARIADNE. ARL:UT participated in a detailed assessment of the acoustic environment in potential deployment regions for these systems. The results have been used to identify system design options and sensor gain requirements. An extensive analysis of the spatial and temporal properties of low frequency acoustic ambient noise near the ocean bottom also was conducted based on several bottom-deployed hydrophone arrays in deep Atlantic and Pacific basins. The results have been used in sensor design for FDS, ARIADNE and advanced sonobuoy systems. The analysis has focused on determining exploitable characteristics of temporal/spatial properties of the noise field and providing recommendations on sensor designs to detect the future threat.

ACTIVE SONAR CLASSIFICATION

ARL:UT played a major role in the CNO Urgent ASW Research Program (CUARP) on active sonar classification, participating in most phases from concept formulation and requirements analysis through implementation and sea tests of an advanced development model (ADM). A major accomplishment was the successful sea testing of an automatic classifier ADM for tactical active ASW sonar. Significant enhancements to this initial ADM are under development and scheduled for sea testing next year. These enhancements

MAJOR ACCOMPLISHMENTS (cont.)

should improve the time response of the system as well as provide longer range and lower frequency capability.

HIGHER ORDER SPECTRAL PROCESSING

ARL:UT has conducted research into new processing methods to extract signals from noise and information from signals that cannot be accomplished with conventional processing. Conventional methods like power spectrum processing measure energy levels of various frequency components of a signal but do not exploit phase relationships between frequency components. Higher order spectra like the bispectrum will exploit these phase relationships. Theoretical calculations and experimental data have shown that bispectrum processing can detect signals at lower signal-to-noise ratios (SNR) than power spectrum processing and can extract features of the signal that do not exist in the power spectrum.

AIRBORNE MEASUREMENT SYSTEM

ARL:UT developed "roll-on, roll-off" instrumentation and procedures for rapid augmentation of a P-3C to collect high quality, calibrated acoustic data. ARL:UT's POCO AMIGO equipment can be installed on a Fleet P-3C and calibrated in a few hours. The use of a P-3C to collect acoustic data does not provide the flexibility of shipboard operations; however, sonobuoys and air dropped explosives can be used to obtain a regional assessment of acoustic propagation and ambient noise much more quickly and with less visibility than shipboard operations. Particularly significant are several data sets collected in Arctic MIZ regions, which have contributed significantly to the Navy's improved understanding of the acoustic environment in these areas.

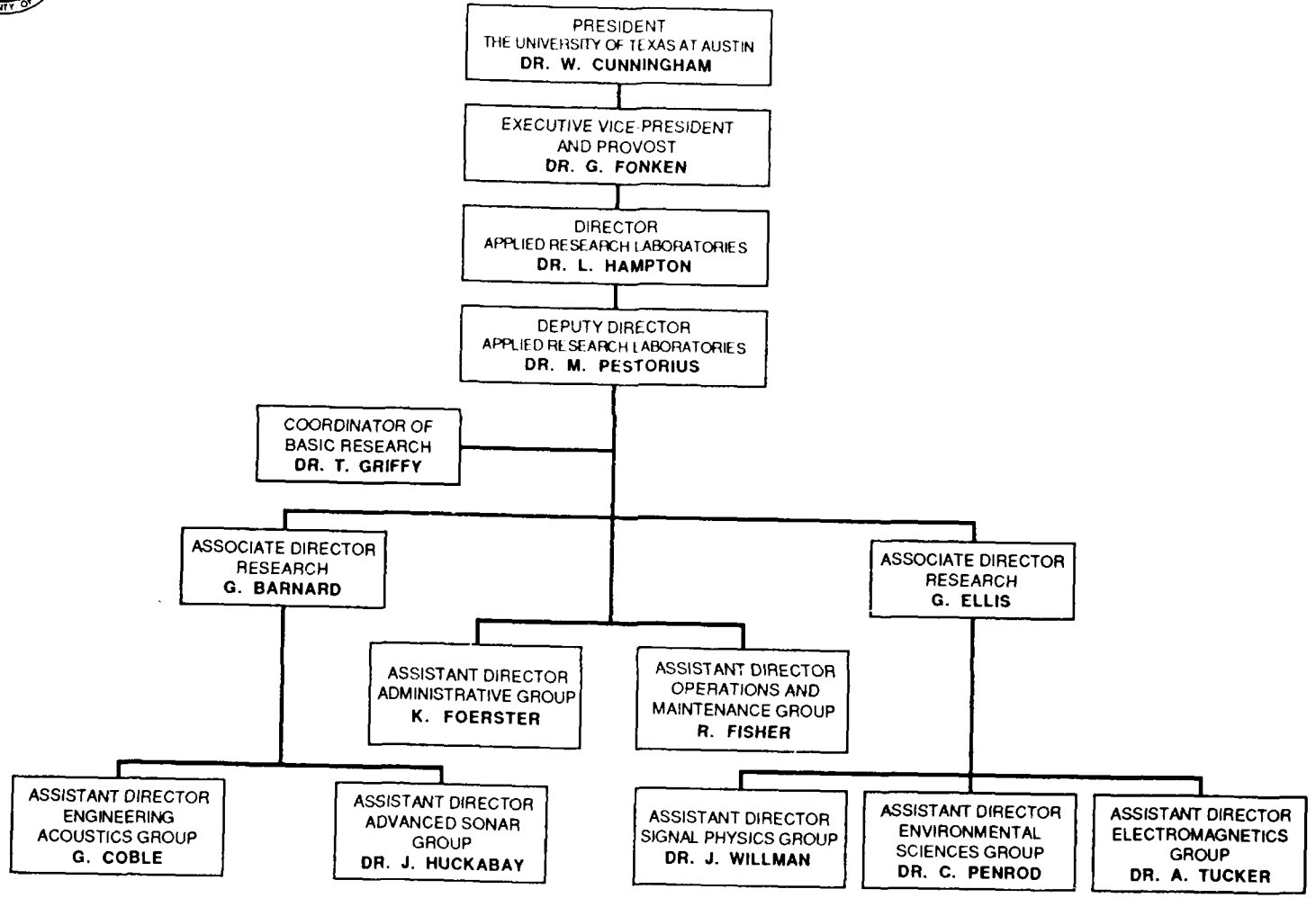
BROADBAND ACOUSTIC MODELING

ARL:UT has developed acoustic modeling tools which describe the effects of the ocean environment on the propagation of broadband acoustic signals. These tools allow the user to simultaneously examine the effects of a complex ocean bottom, including layered bottoms, multipath propagation, source/receiver motion, interaction with the sea surface and selected signal processing algorithms. The capability to analyze the interplay between various combinations of these factors is especially significant. These modeling tools have been applied to analysis and interpretation of data from various experiments with advanced sonobuoy systems and distributed surveillance systems, significantly improving the Navy's understanding of sensor/processing requirements for detection of broadband signals.

PLASMA SOUND SOURCE

The Plasma Sound Source (PSS) project involves research on innovative generation of low frequency, intense sound for underwater applications. Sound is generated by the dynamic expansion and collapse of a steam bubble created by the underwater discharge of high energy electrical arcs. Advances in rotational energy storage have led to the development of compulsators and homopolar generators having energy densities sufficient to allow PSS to achieve new performance levels relative to system weight vice traditional capacitor energy storage. Studies include electro-acoustic efficiencies/source levels, time dependent load impedance energy storage/switching mechanisms, and electrode design/endurance. These factors have been measured and analyzed at relatively low energies to support the design and development of higher energy systems for open ocean testing.

ARL:UT ORGANIZATIONAL STRUCTURE



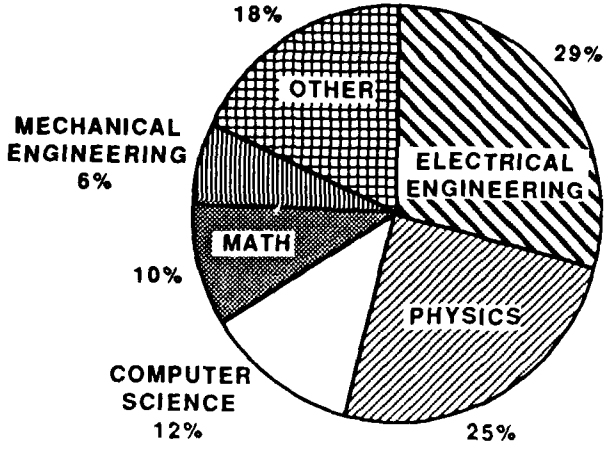
30 SEPTEMBER 1987

MANPOWER SUMMARY

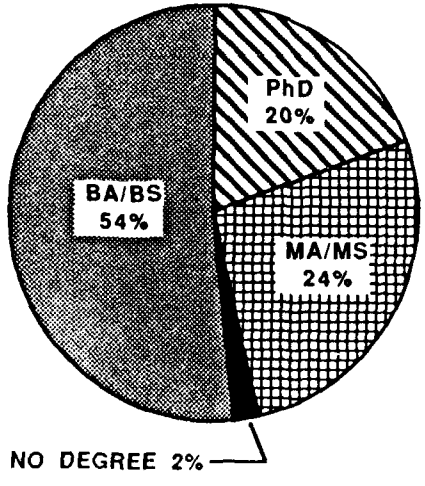
RESEARCH STAFF (SCIENTISTS AND ENGINEERS)	162
FACULTY	20
TECHNICAL SUPPORT	86
ADMINISTRATIVE SUPPORT	112
STUDENTS: GRADUATE	33
UNDERGRADUATE	46
TOTAL STAFF	459

RESEARCH STAFF PROFILE

BY DISCIPLINE



BY DEGREE



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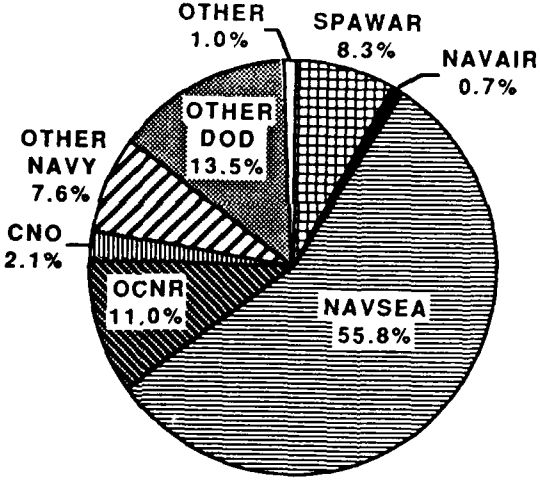
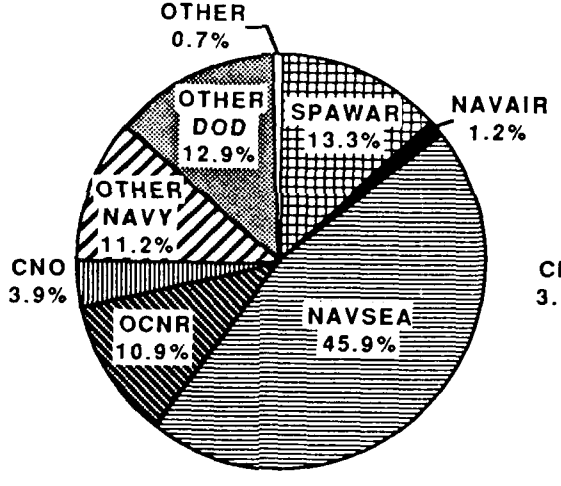
FUNDING BY SPONSOR



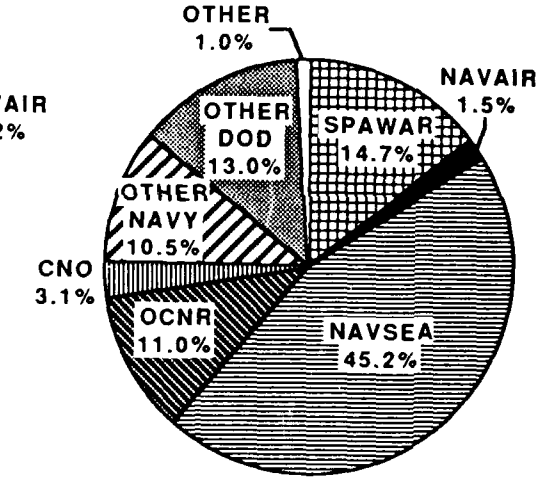
TOTAL: $21,109K

FY 87 (ACTUAL)



TOTAL: $25,654K

FY 88 (PROJECTED)

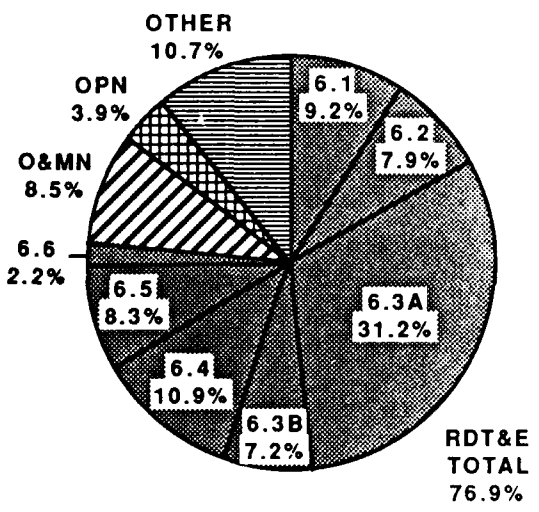


TOTAL: $26,937K

FY 89 (PROJECTED)

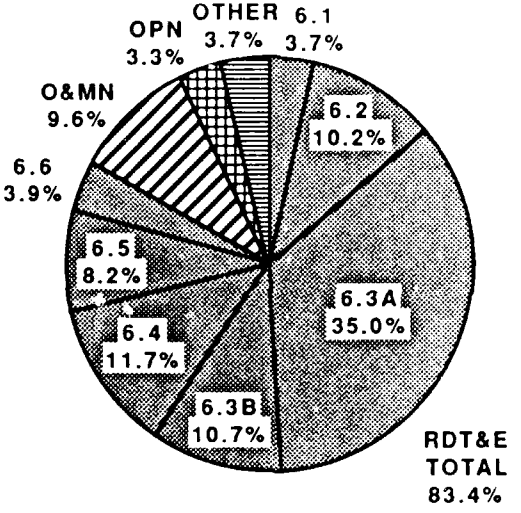
30 SEPTEMBER 1987

FUNDING BY APPROPRIATION



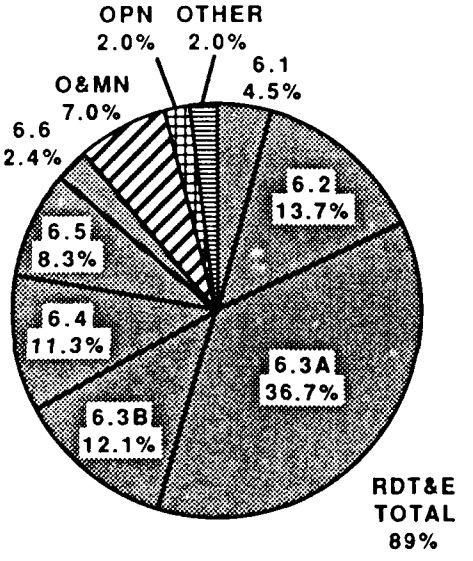
TOTAL: $21,109K

FY 87 (ACTUAL)



TOTAL: $25,654K

FY 88 (PROJECTED)



TOTAL: $26,937K

FY 89 (PROJECTED)

RDT&E

30 SEPTEMBER 1987

FUNDS BY CATEGORY AND TYPE

($ IN THOUSANDS)

CATEGORIES AND TYPE	FY 1987			FY 1988			FY 1989		
	$K ACTUAL	% OF RDT&E	% OF TOTAL	$K PLANNED	% OF RDT&E	% OF TOTAL	$K PLANNED	% OF RDT&E	% OF TOTAL
RDT&E CATEGORY (ALL DOD)									
6.1 RESEARCH	1,947	12.0	9.2	961	4.5	3.7	1,212	5.1	4.5
6.2 EXPLORATORY DEVELOPMENT	1,670	10.3	7.9	2,620	12.3	10.2	3,690	15.4	13.7
6.3a ADVANCED TECHNOLOGY DEVELOPMENT	6,594	40.6	31.2	8,971	41.9	35.0	9,886	41.2	36.7
SUBTOTAL	10,211	62.9	48.3	12,552	58.7	48.9	14,788	61.7	54.9
6.3b ADVANCED DEVELOPMENT	1,512	9.3	7.2	2,737	12.8	10.7	3,259	13.6	12.1
6.4 ENGINEERING DEVELOPMENT	2,299	14.2	10.9	3,000	14.0	11.7	3,044	12.7	11.3
6.5 MANAGEMENT AND SUPPORT	1,758	10.8	8.3	2,107	9.8	8.2	2,236	9.3	8.3
6.6 OPERATIONAL SYSTEMS DEVELOPMENT	458	2.8	2.2	1,000	4.7	3.9	646	2.7	2.4
SUBTOTAL	6,027	37.1	28.6	8,844	41.3	34.5	9,185	38.3	34.1
TOTAL RDT&E	16,238	100.0	76.9	21,396	100.0	83.4	23,973	100.0	89.0
(O&M,N) OPER. AND MAINT., NAVY	1,803	–	8.5	2,449	–	9.6	1,886	–	7.0
(OPN) OTHER PROCUREMENT, NAVY	820	–	3.9	854	–	3.3	539	–	2.0
ALL OTHER	2,248	–	10.7	955	–	3.7	539	–	2.0
OTHER APPROPRIATION SUBTOTAL	4,841	–	23.1	4,258	–	16.6	2,964	–	11.0
TOTAL	21,109	–	100.0	25,654	–	100.0	26,937	–	100.0

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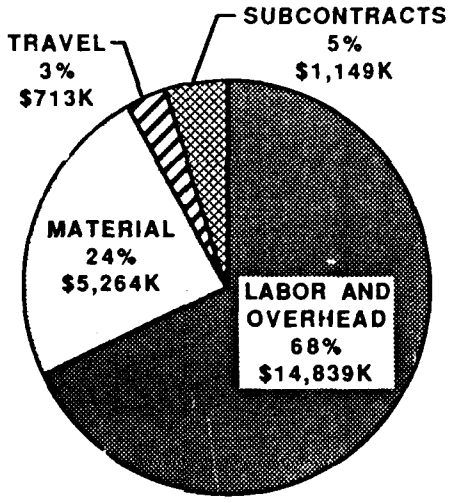
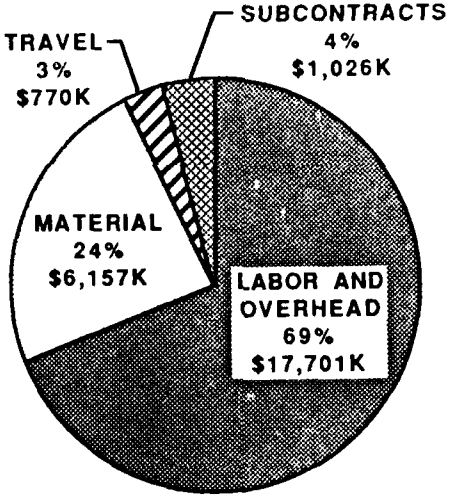
DISTRIBUTION OF FUNDS



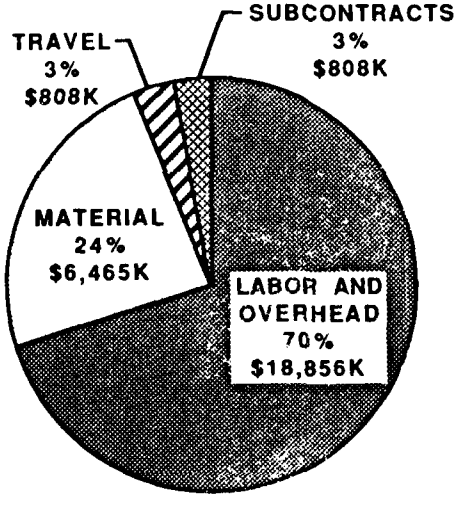
TOTAL: $21,965K

FY 87 (ACTUAL)



TOTAL: $25,654K

FY 88 (PROJECTED)



TOTAL: $26,937K

FY 89 (PROJECTED)

30 SEPTEMBER 1987